Health Risk Assessment for the Central Maintenance Facility

Prepared for:

METROLINK®

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Executive Summary

ES.1 Description of the CMF

The Central Maintenance Facility (CMF) is located at 1555 N San Fernando Road, Los Angeles, CA 90065, on a small parcel of property that once housed the much larger Southern Pacific's Taylor Yard. That rail yard began servicing locomotives and rail cars in 1923. The Southern California Regional Rail Authority (Metrolink) began servicing trains on a portion of that yard in 1991. Use of the facility was agreed upon in a 1992 Memorandum of Understanding (MOU) with the City of Los Angeles and the Los Angeles County Transportation Commission (Metro). Figure ES-1 shows the location of the CMF in relation to the surrounding community.

The CMF is Metrolink's primary heavy service facility and is uniquely equipped to fuel Metrolink locomotives. Following early morning peak runs, nearly all Metrolink trains arrive at the CMF to be inspected, tested, fueled, cleaned, and serviced for afternoon departures. Standard required testing usually takes between 45 and 60 minutes per train, barring any necessary repairs. During the inspection and testing process, the locomotives are required to be running to perform various functional tests mandated by federal regulations (Code of Federal Regulations 49 Parts 200 – 299). After the trains are tested and inspected, they are staged on storage tracks prior to afternoon and evening departures. Most activity at the CMF occurs between 4 a.m. and 8 p.m.

ES.2 Origin of the CMF HRA

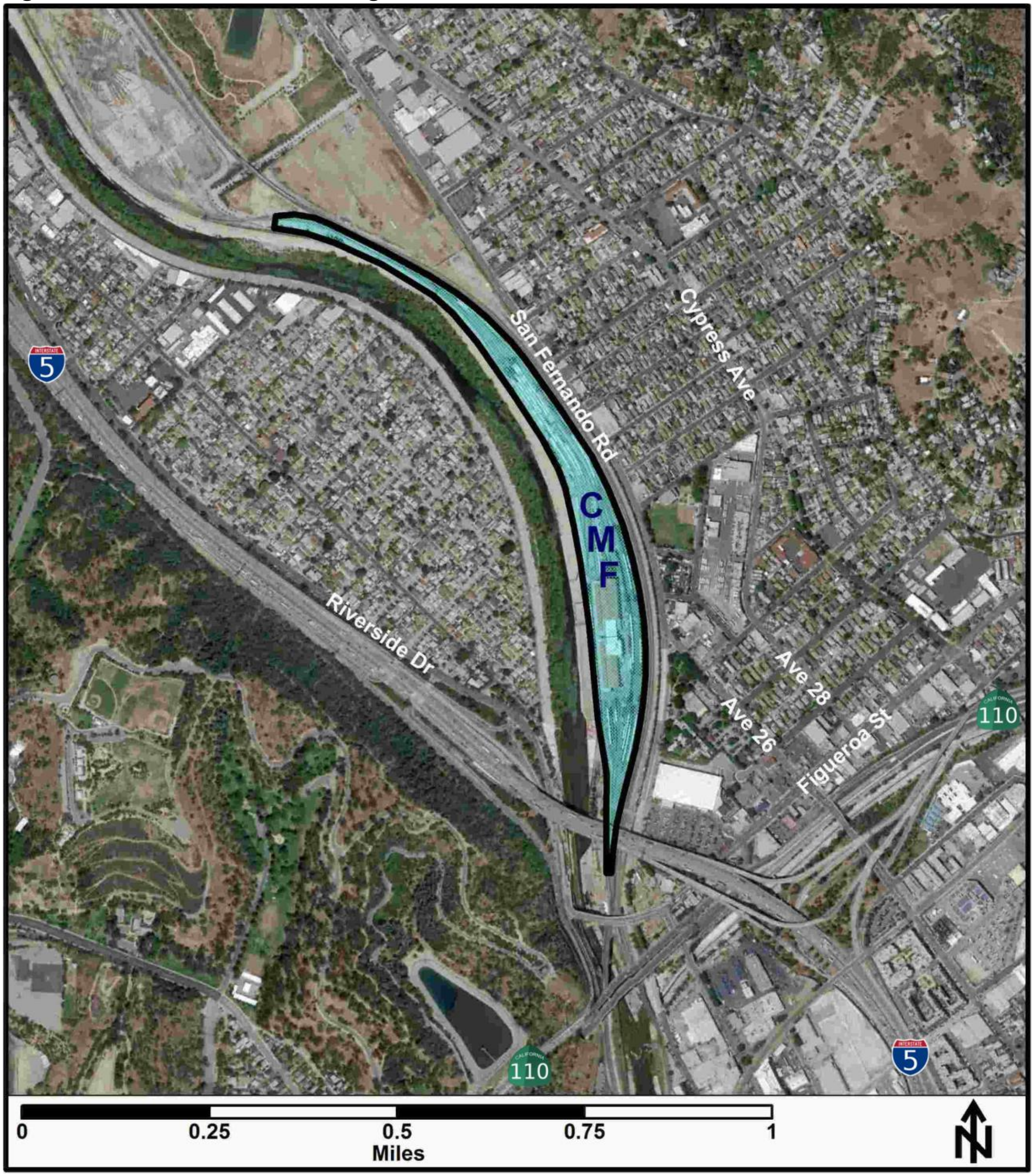
In response to concerns raised by residents of surrounding communities, Metrolink has voluntarily prepared a health risk assessment (HRA) of diesel particulate matter (diesel PM) emissions released from its CMF. The HRA also estimates potential health risks from significant off-site emission sources within one mile of the CMF.

An HRA uses mathematical models to evaluate the health risks from exposure to certain chemicals or toxic air contaminants released from a facility or found in the air. HRAs provide information to estimate potential long-term cancer and non-cancer health risks. HRAs do not gather information or health data on specific individuals, but are estimates for the potential health risks to a population at large.

The purpose of the CMF HRA is to estimate the potential health risks from CMF emissions to persons living and working in the nearby neighborhoods. This HRA also demonstrates the declining health risks resulting from various emission reduction measures both planned and already implemented by Metrolink.

The CMF HRA was prepared using current risk assessment guidelines published by the California Office of Environmental Health Hazard Assessment (OEHHA, 2003) and rail yard-specific supplemental guidelines published by the California Air Resources Board (CARB, 2006). The HRA uses a dispersion model to estimate ambient air concentrations of diesel PM in the vicinity of the CMF resulting from CMF emissions. Toxicity factors are then applied to the estimated air concentrations to estimate health risks to persons living and working in the surrounding communities. The CMF HRA is similar in approach to 17 other HRAs for major California rail yards prepared by the California Air Resources Board (CARB) in 2007 pursuant to a 2005 agreement with the Class I railroads. The CARB rail yard HRAs represent the industry standard for rail yard HRAs in California.

Figure ES-1. CMF and Surrounding Areas



The CMF HRA is based on a CMF emissions assessment that was reviewed by the South Coast Air Quality Management District (SCAQMD) and presented as draft to community working group members in June 2013. Based upon feedback from the SCAQMD and community working group, the emissions assessment was subsequently updated and finalized for use in the HRA.

Following the emissions assessment, a protocol for the CMF HRA was drafted and presented to the community in September 2013. Based upon feedback and input from community stakeholders, the protocol was amended to include data and factors in excess of what was included in the CARB HRAs. For example, the definition of sensitive receptors was broadened to include recreational users, and health risks are estimated for four different operational years at the CMF: 2010, 2012, 2014, and 2017. Each operational year represents a different stage of implementation of emission reduction measures committed to by Metrolink; traditional HRAs only use one data year. Table ES-1 describes the operational years included in the CMF HRA.

Table ES-1. CMF Analysis Years Evaluated in the HRA

Operational Year	Emission Reduction Measures Implemented
2010	• Baseline operating conditions
2012	• Fuel Conservation Program • Modified CMF yard operations to further reduce time being serviced, noise, and idling
2014	• All of the Operational Year 2012 measures; plus • Reduction in the number of trains serviced at the CMF, from 31 to 26 weekday trains, due to startup of Metrolink's new Eastern Maintenance Facility (EMF) in Colton in the fourth quarter of 2014 • Expanded ground power program (5 additional electric plug in stations, for a total of 14) to provide electric power to rail cars during testing and inspection; and • Purchase of a new electric rail car mover to perform yard switching operations
2017	• All of the Operational Year 2014 measures; plus • Replacement of older locomotives with 20 new locomotives meeting the most stringent (Tier 4) emission standards

ES.2.1 Diesel PM

Consistent with the CARB rail yard HRAs, this HRA focuses on potential health risks associated with diesel particulate matter exhaust (diesel PM) emissions. CARB identified diesel PM as a toxic air contaminant in 1998 based on its potential to cause cancer and other adverse health problems, including respiratory illnesses and increased risk of heart disease. Subsequent research has shown that diesel PM contributes to premature death (CARB, 2002; 2008; 2010b). Exposure to diesel PM is a health hazard, particularly to children, whose lungs are still developing; and the elderly, who may have other serious health problems. Population exposure to diesel PM can also result in increased hospitalizations for respiratory and cardiovascular causes, asthma and other lower respiratory symptoms, acute bronchitis, work loss days, and minor restricted activity days (CARB, 2006b).

Diesel PM is the dominant toxic air contaminant in the South Coast Air Basin, which consists of the non-desert portions of Los Angeles, San Bernardino, and Riverside Counties, and all of Orange County. The *Multiple Air Toxics Exposure Study IV* (MATES-IV), conducted by the SCAQMD, shows that approximately 68 percent of the cancer risk from toxic air contaminants in the Basin is attributed to diesel PM (SCAQMD 2014d). Diesel PM is also the dominant toxic air contaminant in and around a rail yard (CARB, 2007). All locomotives and much of the yard support equipment at the CMF use diesel fuel and therefore generate diesel PM emissions.

The emissions assessment prepared for the CMF HRA covers all sources of diesel PM emissions at the CMF, including:

- Locomotive main engines – used during fueling, servicing, inspection, brake testing, car cleaning, load testing, yard switching, idling, and train movement throughout the yard.

- Locomotive head-end power (HEP) engines – used to provide electricity to the rail cars while not connected to ground power, and during maintenance load tests.

- Yard equipment – includes two emergency generators, two forklifts, a welder, and a diesel rail car mover used to perform switching activities in lieu of locomotives.

- On-Road Trucks – includes fuel and vendor delivery trucks while on CMF property.

ES.3 Description of Off-Site Sources

Off-site emission sources include the following potential diesel PM sources within one mile of the CMF site boundary:

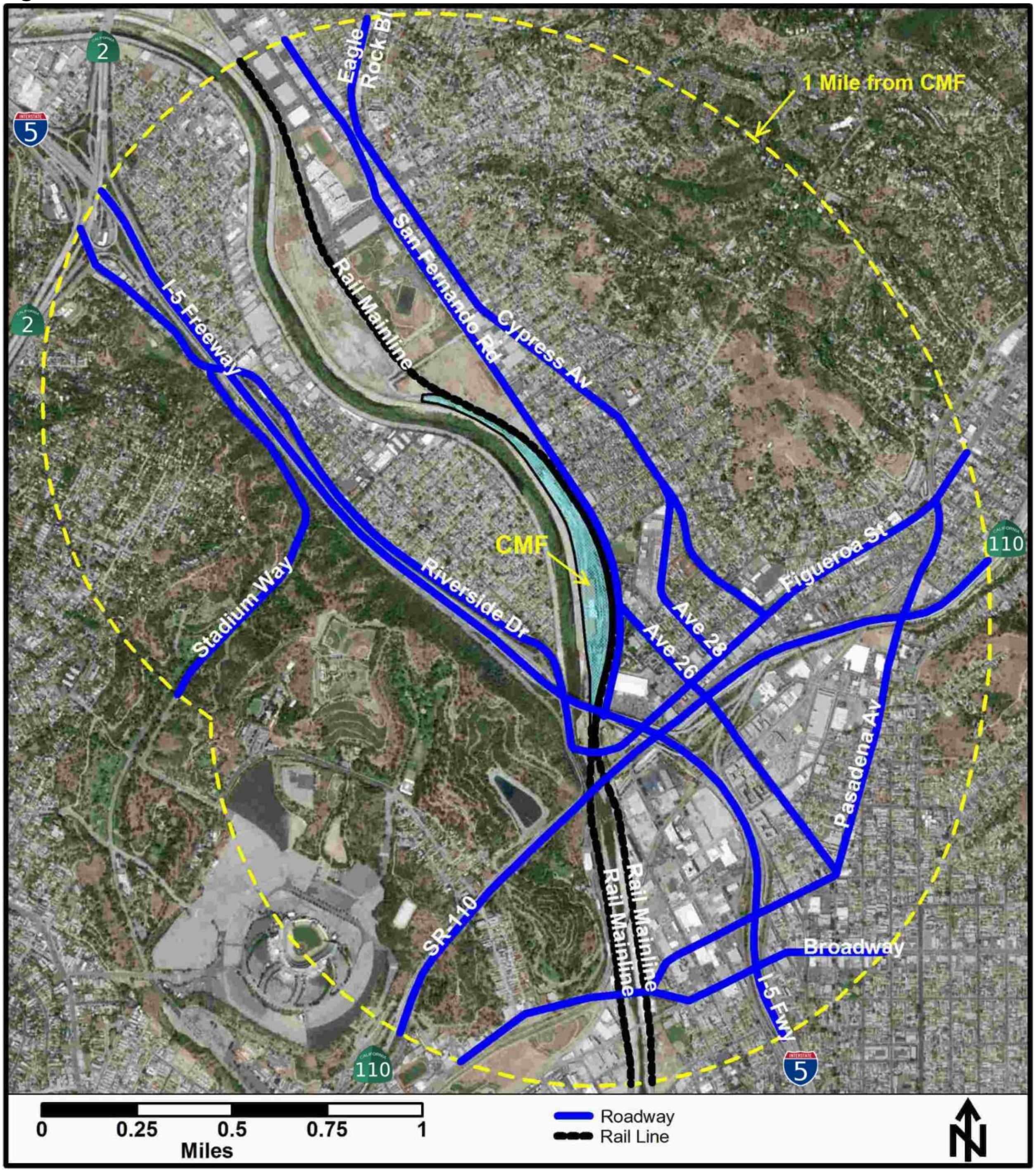
- Diesel trucks traveling on freeways and major surface streets. Trucks include all vehicles with 3 or more axles, except buses, and 2-axle vehicles with dual rear tires. The roadways included in the emissions assessment are the Interstate 5 (I-5) freeway, State Route 110 (SR-110) freeway, San Fernando Road, Riverside Drive, Figueroa Street, Cypress Avenue, Pasadena Avenue, Stadium Way, West Avenue 26, West Avenue 28, North Broadway, and Eagle Rock Boulevard.

- Trains traveling on the rail mainline that runs adjacent to CMF. The emissions assessment includes Metrolink, Amtrak, and freight trains. Emissions that occur inside the CMF are excluded from the off-site emissions assessment.

- Stationary sources such as commercial and industrial businesses. There were 61 stationary sources identified within one mile of the CMF through CARB (2014) and SCAQMD (2014c) records searches. However, these facilities reported no diesel PM emissions in 2010 or 2012. Therefore, stationary sources were not quantified in the off-site sources HRA.

Off-site diesel PM emissions were estimated for the same four operational years as the CMF emissions assessment. The off-site emission sources included in the emissions assessment and HRA are shown in Figure ES-2.

Figure ES-2. Off-Site Sources Included in the HRA



Notes:

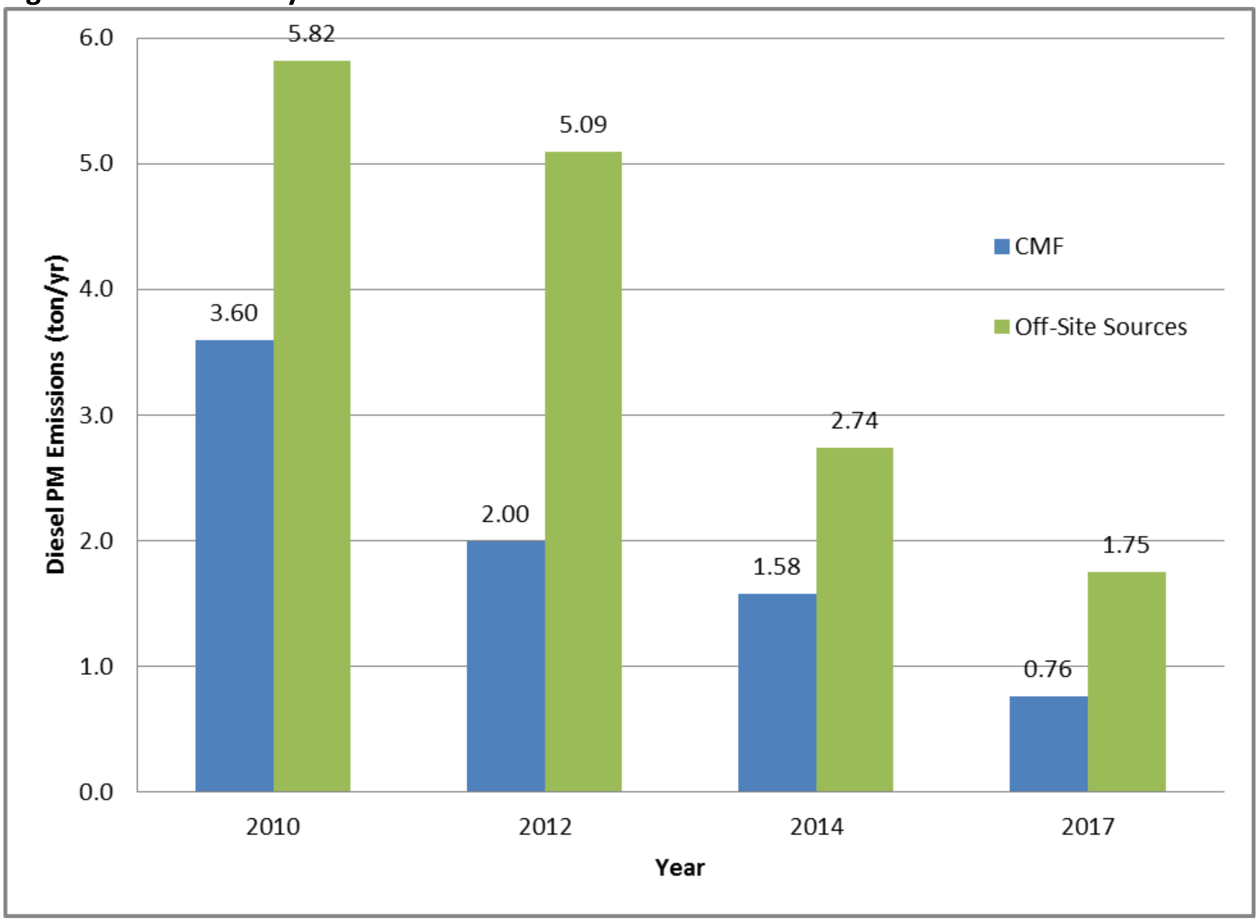
1. Off-site sources are limited to one mile from the CMF boundary.

ES.4 Diesel PM Emissions Assessment

The primary source of diesel PM emissions from the CMF is locomotive main engines. The primary source of diesel PM emissions from the off-site sources is diesel trucks, particularly on I-5. Figure ES-3 summarizes the diesel PM emissions from the CMF and off-site sources for the four operational years of the emissions assessment. The chart shows that the CMF emissions are less than the off-site source emissions for each of the four analysis years. The chart also shows that both the CMF and off-site emissions will decline substantially from 2010 to 2017.

Figure ES-3 shows that **the CMF emissions are predicted to decline 79 percent from 2010 to 2017 in response to the voluntary emission reduction measures implemented by Metrolink**. The off-site diesel PM emissions will also decline from 2010 to 2017 (although not as rapidly as the CMF in terms of percent reduction), primarily in response to the *Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants from In-Use On-Road Diesel-Fueled Vehicles* (CARB, 2010), which requires the phase-in of diesel particulate filters and stricter engine emission standards on heavy duty diesel trucks from 2012 to 2023. As Figure ES-3 indicates, the off-site source emissions are significantly higher than the CMF emissions in each of the study years. The CMF's diesel PM emissions constituted 38 percent of the total CMF plus off-site source emissions in 2010. By 2017, the CMF's diesel PM emissions will be reduced to 30 percent of the total emissions.

Figure ES-3. Summary of Diesel PM Emissions from the CMF and Off-Site Sources



Notes:

1. Off-Site Source emissions occur within one mile of the CMF.

ES.5 Health Risk Assessment

Computer dispersion modeling was performed to estimate concentrations of diesel PM in the air resulting from CMF and off-site source emissions. The U.S. EPA dispersion model, AERMOD v. 14134 (U.S. EPA, 2014) was used together with five years of hourly meteorological data from the SCAQMD's Central Los Angeles (CELA) site (SCAQMD, 2014) to estimate the diesel PM concentrations. The CELA meteorological station is located approximately 1 ¼ miles south of the CMF's southern boundary. AERMOD predicted five-year average diesel PM concentrations in the air on a grid of 5,492 receptor points in the community surrounding the CMF and off-site sources, as well as at 37 specific sensitive receptors. The sensitive receptors include child care facilities, medical facilities, and schools identified with one mile of the CMF site boundary. In response to public requests, Metrolink also included L.A. River users and L.A. River bike path users as sensitive recreational receptors. Section 4 of this report provides more detail on the dispersion modeling approach, including maps of the modeled receptors.

Health risk values were calculated using the Hotspots Analysis Reporting Program (HARP) risk assessment model, version 1.4f (CARB, 2013b). HARP used the five-year average diesel PM concentrations predicted by AERMOD as inputs. HARP predicted two health risk indicators at each modeled receptor: cancer risk and chronic hazard index.

ES.5.1 Definition of Cancer Risk

Cancer risk is usually expressed as the number of chances or persons in a population of a million people that might contract cancer. For example, the number may be stated as "10 in a million" or "10 chances per million". If a population of one million people was exposed to the same potential cancer risk (e.g., 10 chances per million), then statistics would predict that no more than 10 of those million people exposed would be likely to develop cancer from exposure to toxic air contaminant emissions from a facility.

In accordance with CARB and OEHHA guidelines (CARB, 2006; OEHHA, 2003), the CMF and off-site sources HRA identified maximum cancer risk results for the following exposure scenarios:

- **$MEIR_{70}$** - Maximally-exposed individual resident based on a 70-year lifetime exposure period; evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 liters per kilogram body weight per day (L/kg/day).

- **$MEIR_{30}$** - Maximally-exposed individual resident based on a 30-year exposure period; evaluated with an exposure of 24 hours per day, 350 days per year, for 30 years, and an 80th percentile breathing rate of 302 L/kg/day.

- **MEIW** - Maximally-exposed individual worker; evaluated with an exposure of 8 hours per day, 245 days per year, for 40 years, and an occupational breathing rate of 447 L/kg/day (which equates to 149 L/kg per 8-hour day).

- **Sensitive** - Maximally-exposed sensitive receptor; evaluated using the following assumptions:

  - Child care receptors were evaluated with an exposure of 24 hours per day, 350 days per year, for nine years, and an elevated (child) breathing rate of 581 L/kg/day. The HRA identified and evaluated 12 child care facilities within one mile of the CMF.

  - Medical receptors were evaluated with an exposure of 24 hours per day, 350 days per year, for 30 years, and an 80th percentile breathing rate of 302 L/kg/day. The HRA identified and evaluated four medical facilities within one mile of the CMF.

  - School receptors were evaluated with an exposure of 24 hours per day, 350 days per year, for nine years, and an elevated (child) breathing rate of 581 L/kg/day. The HRA identified and evaluated 19 schools within one mile of the CMF.

  - Recreational receptors were evaluated with an exposure of 2 hours per day, 245 days per year, for 40 years, and an elevated (exercise) breathing rate of 1,097 L/kg/day. Based upon feedback and input from community stakeholders, the HRA evaluated two recreational receptors: L.A. River users (such as kayakers) and L.A. River bike path users.

The cancer risks presented for each analysis year (whether 2010, 2012, 2014, or 2017) conservatively assume that year's diesel PM emissions remain constant for the entire exposure period. This assumption is conservative because emissions are on a declining trend from 2010 to 2017 (as demonstrated by Figure ES-3), and will likely continue to decline beyond 2017 as vehicles and equipment reach the end of their useful life and are replaced by newer, less emissive equipment.

ES.5.2 Definition of Chronic Hazard Index

A reference exposure level (REL) is used to predict if there may be an increased risk of certain types of adverse non-cancer health conditions after chronic (long-term) exposure to toxic air contaminants. To calculate the chronic hazard index, the concentration to which a person is exposed is divided by the REL. Typically, the greater the hazard index is above one, the greater the risk of possible adverse health effects. If the hazard index is less than one, adverse effects are less likely to happen (OEHHA, 2003). In accordance with CARB and OEHHA guidelines (CARB, 2006; OEHHA, 2003), the CMF and off-site sources HRA identified maximum chronic hazard indices for the following exposure scenarios:

- **MEIR** - Maximally-exposed individual resident; assumes continuous long-term exposure to average diesel PM concentration.

- **MEIW** - Maximally-exposed individual worker; assumes continuous long-term exposure to average diesel PM concentration.

- **Sensitive** - Maximally-exposed sensitive receptor; assumes continuous long-term exposure to average diesel PM concentration.

ES.5.3 Health Risks Associated with the CMF

Cancer Risk Associated with the CMF
Table ES-2 presents the maximum estimated cancer risks associated with CMF diesel PM emissions. The values in Table ES-2 represent the highest risks at any modeled receptor for each displayed receptor category. The risks at all other modeled locations are less than the values in the table.

Results are presented for each of the four analysis years included in the emissions assessment. In 2010, prior to implementation of emission reduction measures, the risk for the maximally-exposed individual resident ($MEIR_{70}$) was estimated to be 243 in a million, based on 70-year residential exposure assumptions. In 2012, after implementation of the fuel conservation program and modified yard operations, the $MEIR_{70}$ was estimated to be 113 in a million, a reduction of 54 percent from 2010. In 2014, after a reduction in the number of trains, an expanded ground power program, and introduction of the electric railcar mover, the $MEIR_{70}$ is estimated to be 84 in a million, a reduction of 65 percent from 2010. In 2017, after introduction of 20 Tier 4 locomotives to the Metrolink fleet, the $MEIR_{70}$ is estimated to be 40 in a million, a **reduction of 83 percent from 2010**.

Table ES-2. Maximum Estimated Cancer Risks Associated with the CMF

Receptor	Maximum Estimated Cancer Risk [1] (chances per million people)			
	2010	2012	2014	2017
$MEIR_{70}$	243	113	84	40
$MEIR_{30}$	104	48	36	17
MEIW	162	79	64	30
Sensitive	39	23	18	9
Change in $MEIR_{70}$ Relative to 2010	**--**	**-54%**	**-65%**	**-83%**

Notes:

1. The values reported in the table represent the locations with the highest estimated risk, which are near the CMF boundary. See Section 5 for maps of cancer risk in all locations surrounding the CMF, and for a discussion of the overall background risk from toxic air contaminants measured throughout the South Coast Air Basin.
2. $MEIR_{70}$ - Maximally-exposed individual resident (70-year exposure); evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day.
3. $MEIR_{30}$ - Maximally-exposed individual resident (30-year exposure); evaluated with an exposure of 24 hours per day, 350 days per year, for 30 years, and an 80th percentile breathing rate of 302 L/kg/day.
4. MEIW - Maximally-exposed individual worker; evaluated with an exposure of 8 hours per day, 245 days per year, for 40 years, and an occupational breathing rate of 447 L/kg/day (which equates to 149 L/kg per 8-hour day).
5. Sensitive - Maximally-exposed sensitive receptor.

Chronic Hazard Indices Associated with the CMF

Table ES-3 presents the maximum estimated chronic hazard indices associated with CMF diesel PM emissions. The table shows that the hazard indices are less than 1.0 at all modeled receptors in all analysis years. According to OEHHA guidelines (OEHHA, 2003), these levels indicate that the CMF is not expected to cause a substantial non-cancer health risk to the public from diesel PM above the background risk level that already exists throughout the South Coast Air Basin. The chronic hazard indices show a similar declining trend as the cancer risk values, achieving a reduction of 83 percent by 2017 compared to 2010.

Table ES-3. Maximum Estimated Chronic Hazard Indices Associated with the CMF

Receptor	Maximum Estimated Chronic Hazard Index [1]			
	2010	2012	2014	2017
MEIR	0.15	0.07	0.05	0.03
MEIW	0.23	0.11	0.09	0.04
Sensitive	0.09	0.06	0.05	0.02
Change in MEIR Relative to 2010	**--**	**-54%**	**-65%**	**-83%**

Notes:

1. The values reported in the table represent the locations with the highest estimated hazard indices, which are near the CMF boundary.
2. MEIR - Maximally-exposed individual resident.
3. MEIW - Maximally-exposed individual worker.
4. Sensitive - Maximally-exposed sensitive receptor.

Impacted Areas and Population Associated with the CMF

Table ES-4 presents the estimated number of acres and residents exposed to various ranges of cancer risks associated with CMF diesel PM emissions. The cancer risks used to determine the quantities in the table reflect 70-year residential exposure assumptions. The population-based analysis was conducted by modeling census block centroids (the population-weighted centers of census blocks) in AERMOD and HARP. The entire population of each census block was assumed to be exposed to the cancer risk at the centroid. HARP contains census data from the U.S. Census Bureau's 2000 Census (CARB, 2013b). For each analysis year, the population was scaled up from the 2000 Census data assuming a 10-year growth rate of 3.1 percent for Los Angeles County (U.S. Census Bureau, 2011).

Table ES-4 shows that, from 2010 to 2017, both the geographical area and number of persons exposed to each range of cancer risk will decrease substantially. For example, the geographical area exposed to a 70-year residential cancer risk greater than or equal to 10 in a million will decrease from 574 acres in 2010 to 160 acres in 2017 (including the acreage of the CMF itself), a decrease of 72 percent. Similarly, the number of persons exposed to a 70-year residential cancer risk greater than or equal to 10 in a million will decrease from 11,453 persons in 2010 to 2,775 persons in 2017, a decrease of 76 percent.

Table ES-4. Estimated Impacted Areas and Population Exposed to Various Cancer Risk Levels from the CMF

Cancer Risk Range (per million)	Estimated Impacted Area (acres)				Estimated Exposed Population (persons)			
	2010	2012	2014	2017	2010	2012	2014	2017
10-25	295	215	168	99	6,193	5,566	4,261	2,707
26-50	130	90	64	39	2,607	2,573	1,744	68
51-100	75	49	38	21	1,763	77	68	0
101-250	53	36	23	0	890	67	0	0
> 250	21	2	0	0	0	0	0	0
Total ≥ 10	**574**	**391**	**293**	**160**	**11,453**	**8,283**	**6,073**	**2,775**
Change Relative to 2010	**--**	**-32%**	**-49%**	**-72%**	**--**	**-28%**	**-47%**	**-76%**

Notes:

1. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine $MEIR_{70}$).
2. The cancer risk ranges displayed in the table were selected for the purposes of comparison and discussion. The 10-per-million level was selected as the lowest range of cancer risk in the table because this level of risk is predicted to occur roughly on a local community scale.

Impacted Sensitive Receptors Associated with the CMF

Table ES-5 presents the number of modeled sensitive receptors exposed to various ranges of cancer risks associated with CMF diesel PM emissions. Each of the 37 sensitive receptors was modeled with the exposure assumptions appropriate for its receptor classification (child care, medical, school, or recreational), as described above under *Definition of Cancer Risk*. Table ES-5 shows that, in 2010, 33 sensitive receptors were exposed to a cancer risk less than or equal to 10 in a million, two were exposed to a cancer risk between 11 and 25 in a million, and two were exposed to a cancer risk between 26 and 50 in a million. By 2017, all modeled sensitive receptors will be exposed to a cancer risk less than 10 in a million.

Table ES-5. Estimated Number of Sensitive Receptors Exposed to Various Cancer Risk Levels from the CMF

Cancer Risk Range (per million)	Number of Sensitive Receptors			
	2010	2012	2014	2017
0-10	33	35	35	37
11-25	2	2	2	0
26-50	2	0	0	0
51-100	0	0	0	0
101-250	0	0	0	0
> 250	0	0	0	0

Notes:

1. Modeled sensitive receptors are within one mile of the CMF.
2. The cancer risk ranges displayed in the table were selected for the purposes of comparison and discussion.

ES.5.4 Health Risks Associated with Off-Site Sources

Cancer Risk Associated with Off-Site Sources

Table ES-6 presents the maximum estimated cancer risks associated with off-site source diesel PM emissions. Results are presented for each of the four analysis years included in the emissions assessment. Diesel truck traffic on I-5 accounts for 96 to 98 percent of the cancer risk at the MEIR, depending on the analysis year.

The values in Table ES-6 represent the highest risks at any modeled receptor for each displayed receptor category. The risks at all other modeled locations are less than the values in the table.

Table ES-6. Maximum Estimated Cancer Risks Associated with Off-Site Sources

Receptor	Maximum Estimated Cancer Risk [1] (chances per million people)			
	2010	2012	2014	2017
$MEIR_{70}$	401	346	160	103
$MEIR_{30}$	172	148	69	44
MEIW	174	150	70	45
Sensitive	70	60	28	18
Change in $MEIR_{70}$ Relative to 2010	**--**	**-14%**	**-60%**	**-74%**

Notes:

1. The values reported in the table represent the locations with the highest estimated risk, which are near the I-5 freeway. See Section 5 for maps of cancer risk in all locations in the study area, and for a discussion of the overall background risk from toxic air contaminants measured throughout the South Coast Air Basin.
2. $MEIR_{70}$ - Maximally-exposed individual resident (70-year exposure); evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day.
3. $MEIR_{30}$ - Maximally-exposed individual resident (30-year exposure); evaluated with an exposure of 24 hours per day, 350 days per year, for 30 years, and an 80th percentile breathing rate of 302 L/kg/day.
4. MEIW - Maximally-exposed individual worker; evaluated with an exposure of 8 hours per day, 245 days per year, for 40 years, and an occupational breathing rate of 447 L/kg/day (which equates to 149 L/kg per 8-hour day).
5. Sensitive - Maximally-exposed sensitive receptor.

Chronic Hazard Indices Associated with Off-Site Sources

Table ES-7 presents the maximum estimated chronic hazard indices associated with off-site diesel PM emissions. The table shows that the hazard indices are less than 1.0 at all modeled receptors in all analysis years. According to OEHHA guidelines (OEHHA, 2003), these levels indicate that the off-site sources within one mile of the CMF are not expected to cause a substantial non-cancer health risk to the public from diesel PM above the background risk level that already exists throughout the South Coast Air Basin. The chronic hazard indices show a similar declining trend as the cancer risk values, achieving a reduction of 74 percent by 2017 compared to 2010.

Table ES-7. Maximum Estimated Chronic Hazard Indices Associated with Off-Site Sources

Receptor	Maximum Estimated Chronic Hazard Index [1]			
	2010	2012	2014	2017
MEIR	0.25	0.22	0.10	0.06
MEIW	0.25	0.22	0.10	0.06
Sensitive	0.17	0.15	0.07	0.04
Change in MEIR Relative to 2010	**--**	**-14%**	**-60%**	**-74%**

Notes:

1. The values reported in the table represent the locations with the highest estimated hazard indices, which are near the I-5 freeway.
2. MEIR - Maximally-exposed individual resident.
3. MEIW - Maximally-exposed individual worker.
4. Sensitive - Maximally-exposed sensitive receptor.

Impacted Areas and Population Associated with Off-Site Sources

Table ES-8 presents the estimated number of acres and residents exposed to various ranges of cancer risks associated with off-site diesel PM emissions. The cancer risks used to determine the quantities in the table reflect 70-year residential exposure assumptions. Table ES-8 shows that, from 2010 to 2017, both the geographical area and number of persons exposed to each range of cancer risk will decrease substantially. For example, the geographical area exposed to a 70-year residential cancer risk greater than or equal to 10 in a million will decrease by 75 percent. Similarly, the number of persons exposed to a 70-year residential cancer risk greater than or equal to 10 in a million will decrease by 83 percent.

Table ES-8. Estimated Impacted Areas and Population Exposed to Various Cancer Risk Levels from Off-Site Sources

Cancer Risk Range (per million)	Estimated Impacted Area (acres)				Estimated Exposed Population (persons)			
	2010	2012	2014	2017	2010	2012	2014	2017
10-25	5,316	4,617	1,722	1,216	121,657	99,280	29,532	20,338
26-50	1,381	1,194	737	530	21,728	19,061	9,060	6,084
51-100	783	734	347	151	9,011	7,519	4,028	1,164
101-250	392	306	157	97	5,495	4,171	314	0
> 250	173	148	22	0	310	175	0	0
Total ≥ 10	**8,047**	**6,998**	**2,985**	**1,994**	**158,201**	**130,206**	**42,934**	**27,586**
Change Relative to 2010	**--**	**-13%**	**-63%**	**-75%**	**--**	**-18%**	**-73%**	**-83%**

Notes:

1. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine $MEIR_{70}$).
2. The cancer risk ranges displayed in the table were selected for the purposes of comparison and discussion. The 10-per-million level was selected as the lowest range of cancer risk in the table because this level of risk is predicted to occur roughly on a local community scale.

Impacted Sensitive Receptors Associated with Off-Site Sources

Table ES-9 presents the number of modeled sensitive receptors exposed to various ranges of cancer risks associated with off-site diesel PM emissions. Each of the 37 sensitive receptors was modeled with the exposure assumptions appropriate for its receptor classification (child care, medical, school, or recreational), as described above under *ES.5.1 Definition of Cancer Risk*. Table ES-9 shows that in 2010, 15 sensitive receptors were exposed to a cancer risk less than or equal to 10 in a million, 12 were exposed to a cancer risk between 11 and 25 in a million, 6 were exposed to a cancer risk between 26 and 50 in a million, and 4 were exposed to a cancer risk between 51 and 100 in a million. By 2017, 31 sensitive receptors will be exposed to a cancer risk less than or equal to 10 in a million, and six will be exposed to a cancer risk between 11 and 25 in a million.

Table ES-9. Estimated Number of Sensitive Receptors Exposed to Various Cancer Risk Levels from Off-Site Sources

Cancer Risk Range (per million)	Number of Sensitive Receptors			
	2010	2012	2014	2017
0-10	15	16	26	31
11-25	12	13	8	6
26-50	6	5	3	0
51-100	4	3	0	0
101-250	0	0	0	0
> 250	0	0	0	0

Notes:

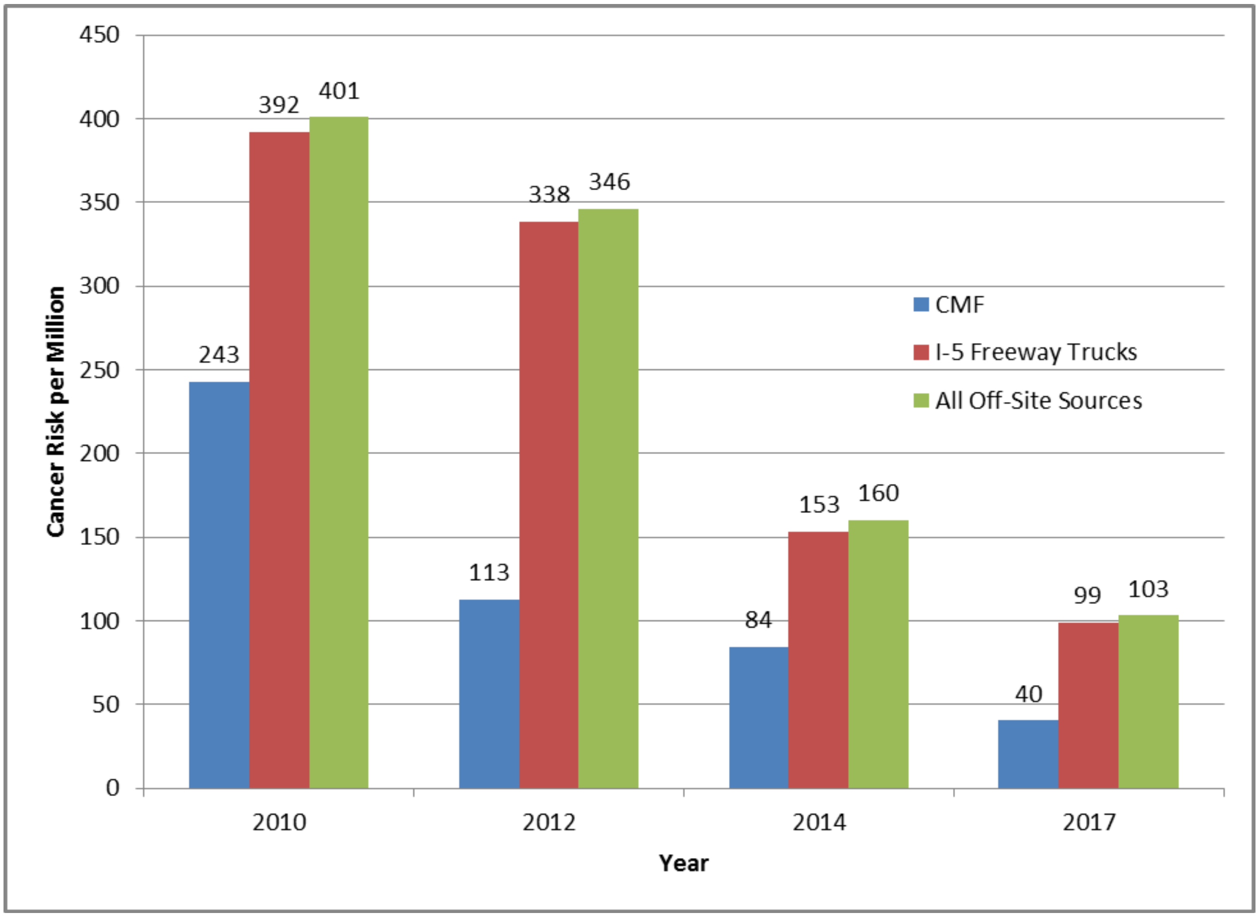
1. Modeled sensitive receptors are within one mile of the CMF.
2. The cancer risk ranges displayed in the table were selected for the purposes of comparison and discussion.

ES.5.5 Comparison of Health Risks Associated with the CMF and Off-Site Sources

Figure ES-4 shows a graphical comparison of the maximally exposed individual residents with 70 years exposure ($MEIR_{70}$) estimated for the CMF and off-site sources. The displayed cancer risk values reflect 70-year residential exposure assumptions. Because diesel truck traffic on I-5 is such a dominant contributor to the risk from off-site sources, I-5 is shown by itself in the chart. I-5 is also included in the risks shown for "All Off-Site Sources".

Figure ES-4 shows that, in each analysis year, the CMF generates less cancer risk than either I-5 by itself or all off-site sources combined at their respective maximum cancer risk locations. The chart also shows that the declining trend in CMF cancer risk is more rapid than the declining trend in off-site sources risk. For example, in 2010, the CMF cancer risk is 61 percent as great as the off-site sources risk. By 2017, the CMF cancer risk is 39 percent of the off-site sources risk. This rapid decline in CMF cancer risk is a direct result of the emission reduction measures put into place by Metrolink at the CMF.

Figure ES-4. Comparison of Maximum Residential Cancer Risks ($MEIR_{70}$) from the CMF and Off-Site Sources

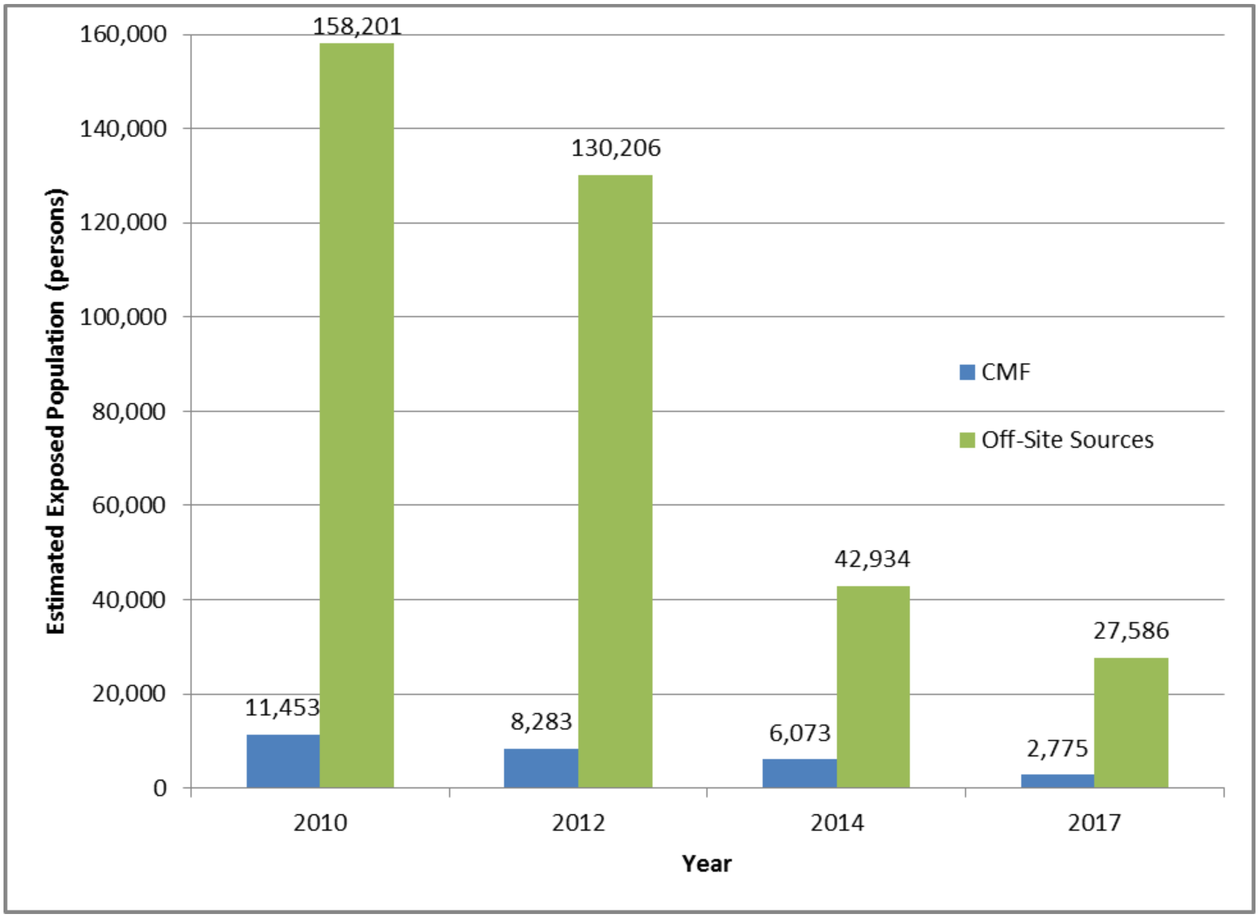


Notes:

1. The values reported in the chart represent the locations with the highest estimated cancer risk for each displayed source category. These maximum risk locations are near the CMF boundary for the CMF HRA, and near I-5 for the off-site sources HRA. See Section 5 for maps of cancer risk in all locations throughout the study area.
2. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine $MEIR_{70}$).
3. Cancer risks from the CMF are associated with on-site diesel PM emissions.
4. Cancer risks from Off-Site Sources are associated with diesel PM emissions occurring within one mile of the CMF.
5. I-5 Freeway Trucks are shown as their own category and are also included in the “All Off-Site Sources” category.
6. The category “All Off-Site Sources” includes diesel trucks and trains operating within one mile of the CMF, excluding emissions within the CMF. Diesel trucks were modeled on I-5, SR-110, San Fernando Rd., Riverside Dr., Figueroa St., Cypress Ave., Pasadena Ave., Stadium Way, W. Ave. 26, W. Ave. 28, N. Broadway, and Eagle Rock Blvd. Trains include Metrolink, Amtrak, and freight trains traveling on the rail mainlines.

Figure ES-5 shows a graphical comparison of the number of residents exposed to a cancer risk greater than or equal to 10 in a million estimated for the CMF and off-site sources. The 10-per-million level was selected as a lower threshold of cancer risk in the figure because this level of risk is predicted to occur roughly on a local community scale. The exposed populations were determined based on 70-year residential exposure assumptions. Figure ES-5 shows that, in each analysis year, the CMF exposes much fewer residents to a cancer risk greater than or equal to 10 in a million than the off-site sources within one mile of the CMF. For example, in 2010, the CMF is estimated to expose 11,453 residents to a cancer risk greater than or equal to 10 in a million, while the off-site sources are estimated to expose 158,201 residents. By 2017, the CMF is estimated to expose 2,775 residents to a cancer risk greater than or equal to 10 in a million, while the off-site sources are estimated to expose 27,586 residents.

Figure ES-5. Comparison of Population Exposed to a Cancer Risk ≥ 10 per Million from the CMF and Off-Site Sources



Notes:

1. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine $MEIR_{70}$).
2. Cancer risks from the CMF are associated with on-site diesel PM emissions.
3. Cancer risks from off-site sources are associated with diesel PM emissions occurring within one mile of the CMF.
4. The 10-per-million level was selected as a lower threshold of cancer risk in the figure because this level of risk is predicted to occur roughly on a local community scale.

ES.5.6 Background Cancer Risk

It is important to note that the risk levels presented in this report for the CMF and for the off-site sources within one mile of the CMF represent just a portion of the overall background risk levels. For the broader South Coast Air Basin, the estimated regional background cancer risk level is estimated to be about 418 in a million caused by all toxic air pollutants, based on actual measurements of toxic air contaminant levels from July 2012 through June 2013 (SCAQMD 2014d).

The SCAQMD, in the MATES-IV report (SCAQMD, 2014d), also provides the following discussion to provide some perspective on cancer risk estimates: "…it is often helpful to compare the risks estimated from assessments of environmental exposures to the overall rates of health effects in the general population. For example, it is often estimated that the incidence of cancer over a lifetime in the U.S. population is in the range of 1 in 4 or 1 in 3. This translates into a risk of about 250,000 to 300,000 in a million. It has also been estimated that the bulk of cancers from known risk factors are associated with lifestyle factors such as tobacco use, diet, and being overweight. One such study, the Harvard Report on Cancer Prevention, estimated that of all cancers associated with known risk factors, about 30% were related to tobacco, about 30% were related to diet and obesity, and about 2% were associated with environmental pollution related exposures."

ES.5.7 Uncertainty in Risk Assessment

Health risk assessment is a complex process that is based on current knowledge and a number of assumptions. Therefore, there is uncertainty associated with the process of risk assessment. The uncertainty arises from lack of data in many areas, necessitating the use of assumptions. The assumptions used in the assessment are often designed to be conservative on the side of health protection in order to avoid underestimation of risk to the public. As indicated by the Office of Environmental Health Hazard Assessment Guidelines, risk assessments are useful in comparing risks among a number of facilities and similar sources. Thus, the risk estimates should not be interpreted as a literal prediction of disease incidence in the affected communities, but more as a tool for comparison of the relative risk between one facility and another. They are also an effective tool for determining the impact a particular emission reduction strategy will have on reducing risks (CARB, 2007).

1. Introduction

In response to concerns raised by residents of surrounding communities, Metrolink has voluntarily prepared a health risk assessment (HRA) of diesel particulate matter (PM) emissions released from its Central Maintenance Facility (CMF). The CMF is located at 1555 N San Fernando Road, Los Angeles, CA 90065, as shown in Figure 1-1.

An HRA uses mathematical models to evaluate the health risks from exposure to certain chemicals or toxic air contaminants released from a facility or found in the air. HRAs provide information to estimate potential long-term cancer and non-cancer health risks. HRAs do not gather information or health data on specific individuals, but are estimates for the potential health risks to a population at large.

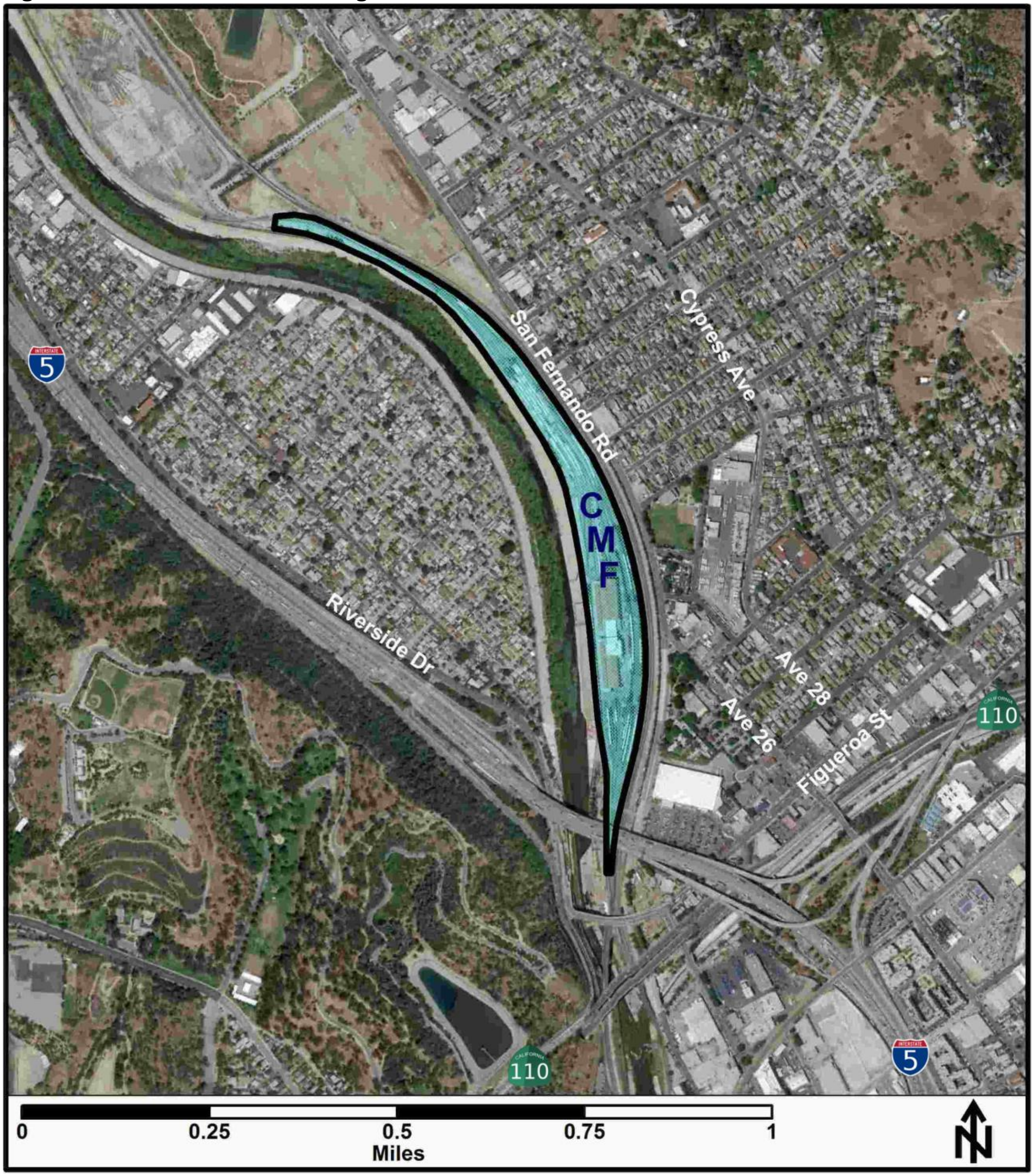
The purpose of the CMF HRA is to estimate the potential health risks from CMF emissions to persons living and working in the surrounding communities. This HRA also demonstrates the declining health risks resulting from various emission reduction measures both planned and already implemented by Metrolink. As supplemental information for purposes of comparison, the HRA also estimates potential health risks from significant off-site emission sources within one (1) mile of the CMF. Although not the primary focus of the CMF HRA, the health risks associated with the off-site pollution sources will provide a point of reference by which the CMF health risk results can be compared and assessed. The CMF and off-site sources included in the HRA are described in greater detail in Sections 2 and 3.

The CMF HRA was prepared using current risk assessment guidelines published by the California Office of Environmental Health Hazard Assessment (OEHHA, 2003) and rail yard-specific supplemental guidelines published by the California Air Resources Board (CARB, 2006). The CMF HRA is similar in approach to 17 other HRAs for major California rail yards prepared by the California Air Resources Board (CARB) in 2007 pursuant to a 2005 agreement with the Class I railroads. The CARB rail yard HRAs represent the industry standard for rail yard HRAs in California. Using this same approach for the CMF HRA will ensure a consistent, reliable, and previously validated methodology, and will allow for a meaningful comparison of the results to those of other rail yards in the region.

The CMF HRA is based on a CMF emissions assessment that was reviewed by the South Coast Air Quality Management District (SCAQMD) and presented as draft to the community working group in June 2013. Based upon feedback from the SCAQMD and community working group, the emissions assessment was subsequently finalized for use in the HRA. The methodology and results of the emissions assessment for the CMF and off-site sources are described in Section 3.

Following the emissions assessment, a protocol for the CMF HRA was drafted and presented to the community in September 2013. The protocol describes the specific approach for conducting the CMF HRA. Based upon feedback and input from community stakeholders, the protocol was amended to include data and factors in excess of what was included in the CARB HRAs. For example, the definition of sensitive receptors was broadened to include recreational users, and health risks are estimated for four different operational years at the CMF: 2010, 2012, 2014, and 2017. Each operational year represents a different stage of implementation of emission reduction measures committed to by Metrolink; traditional HRAs only use one data year. The final HRA protocol is provided in Appendix A.

Figure 1-1. CMF and Surrounding Areas



As part of the HRA process, dispersion modeling was conducted to estimate the concentration of diesel PM in the air to which residents and workers near the CMF are exposed. The dispersion modeling approach is described in Section 4. Health risks were estimated by applying exposure and toxicity factors to the diesel PM concentrations estimated by the dispersion model. The HRA approach is described in Section 5, and the summary and conclusions are presented in Section 6.

2. Site Description

2.1 CMF

Metrolink is a Southern California commuter rail service that averages over 44,000 passenger boardings each weekday. It is estimated that each day over 18,000 cars are removed from the roads by those utilizing Metrolink. In turn, this reduces traffic congestion, air pollution, and the need to construct additional freeway lanes.

The CMF is located on a small parcel of property that once housed the much larger Southern Pacific's Taylor Yard. That rail yard began servicing locomotives and rail cars in 1923. The Southern California Regional Rail Authority (Metrolink) began servicing trains on a portion of that yard in 1991. Use of the facility was agreed upon in a 1992 Memorandum of Understanding (MOU) with the City of Los Angeles and the Los Angeles County Transportation Commission (Metro). The CMF is Metrolink's primary heavy service facility and is uniquely equipped to fuel Metrolink locomotives. Figure 1-2 shows the current layout of the CMF, including the locations of major operational activities at the facility.

The CMF currently services 31 trains each weekday, two trains on Saturday, and one train on Sunday. Trains are inspected, tested, fueled, cleaned, and serviced prior to departure. Typical operating schedules at the CMF are as follows:

Typical Weekday

- The first train is prepared for service at 4 a.m. and departs at 5:15 a.m. The first train arrives at CMF at 6:50 a.m. Trains are serviced until 3:30 p.m. In general, the last inbound train arrives at 8 p.m. The last outbound train departs at 5:45 p.m. Typically, work occurs between 4 a.m. and 8 p.m.

Typical Saturday

- Train No. 1
  - Prepared for service and departs at 6 a.m.
  - Returns at 3 p.m. and is cleaned and serviced
  - Stored for Monday morning service
- Train No. 2
  - Prepared for service and departs at 8 a.m.
  - Returns at 7 p.m. and is prepped for service
  - Departs at 8 p.m.

Typical Sunday

- Train No. 1
  - Prepared for service and departs at 8 a.m.
  - Returns at 7 p.m. and is cleaned and serviced
  - Stored for Monday morning service

Locomotives are fueled via a fueling rack at the north end of the Service and Inspection (S&I) Tracks, in the northern portion of the CMF. Diesel locomotive fuel is delivered to the CMF by fuel trucks. The fuel trucks park in the location shown in Figure 1-2 and dispense their fuel into underground storage tanks.

Figure 1-2: CMF Operational Layout

Standard required testing of trains takes place at two locations on the S&I Tracks (in the northern portion of the CMF) and at three locations on the Storage Tracks (in the southern portion of the CMF). Inspection and testing usually takes between 45 and 60 minutes per train, barring any necessary repairs. During the inspection and testing process, the locomotive main engines are required to be running to perform various functional tests mandated by federal regulations (Code of Federal Regulations 49 Parts 200 – 299). These regulations dictate the frequency and nature of mechanical inspections. The following rules describe the federal requirements:

- 229.21 Daily Inspections - Requires locomotives to be inspected and tested daily.
- 238.303 Exterior Inspections - Exterior mechanical inspection of passenger equipment each calendar day.
- 238.305 Interior Inspections - Interior mechanical inspection of passenger equipment each calendar day.
- 232.205 Class 1 Brake Test Initial Terminal Inspection – Functional air brake test at location where train is assembled.
- 238.313 Class 1 Air Brake Test – Functional air brake test required each calendar day.

After the trains are tested and inspected, they are staged on the Storage Tracks prior to afternoon and evening departures. All arriving and departing trains enter and exit the CMF at the south end.

Locomotives and railcars are also repaired at the CMF. After repairs, the locomotive main and head-end power (HEP) engines are load tested to ensure they are working properly. The locomotive main engine provides propulsion power to the locomotive. The HEP engine is a separate diesel engine contained in the locomotive that provides electric power to the railcars for lights, heating and air conditioning, and other power needs. Currently, 51 of Metrolink's 52 locomotives have both main and HEP engines. The remaining locomotive (Model F40PH) has only a main engine, which provides both propulsion and auxiliary power to the railcars.

Metrolink also has a small fleet of diesel yard equipment to support operations at the CMF. A diesel railcar mover is used to perform most of the switching activities in lieu of locomotives. Two forklifts and a welder are used in the repair and maintenance of locomotives and railcars. Two diesel standby generators are used to supply electric power in the event of a power outage.

2.1.1 CMF Environmental Measures

Since 2010, Metrolink has implemented and plans to implement a number of environmental measures to reduce air and noise impacts associated with the CMF. The measures are described below.

Fuel Conservation Program

Metrolink has a fleet of 52 locomotives that meet all current Federal Railroad Administration (FRA) equipment regulations. Ultra-Low Sulfur Diesel fuel, the cleanest fuel available, is used to power the locomotives. At present, 32 locomotives have been equipped with Automatic Engine Start Stop (AESS) technology. AESS automatically shuts down the main engine of a locomotive if certain operating parameters are met, such as idling for 30 minutes. Metrolink's Fuel Conservation Program also limits fuel consumption of idling trains prior to dispatching for passenger service, and arriving trains enter the CMF with the HEP engines already turned off. Metrolink also modified its yard operations at the CMF to further reduce time being serviced, noise, and idling. Specifically, trains are now serviced, tested, and inspected on both the S&I Tracks and the Storage Tracks. Before this modification, this was done only on the S&I tracks. Consequently, all operations are performed with minimal locomotive idling. The fuel program saved 860,000 gallons of fuel in 2010-11 compared to the previous year, while reducing emissions and noise generated by idling locomotives.

Pilot Plug-in Program

In April 2012, Metrolink implemented a pilot Plug-in Program, which uses ground power at the CMF in lieu of diesel HEP engine power. This technology enables HEP engines to be turned off while railcars run on electricity throughout a portion of the daily servicing and maintenance routine. This innovation reduces emissions generated by the locomotive HEP engines. Currently, the CMF features nine (9) "plug-ins" which allows up to 17 locomotives to use this technology on a daily basis. An additional five (5) plug-ins are also being planned for operation on the CMF's storage tracks starting in 2014. More than 20 trains are expected to use electrical power during servicing once the project is complete.

Reduced Noise Pollution

Metrolink abides by the Code of Federal Regulations to reduce the use of bell ringing at CMF. Since the "reduced use of bells policy" was initiated in January 2012, use of bell ringing has decreased by 85%.

Railcar Mover

For evening service equipment movements, a diesel railcar mover has been used at the CMF in lieu of locomotives. Metrolink makes an effort to utilize the car mover to reduce noise levels. The procurement of a new electric zero-emission car mover was completed in 2014. Based upon the MOU with the City of Los Angeles, Metrolink locomotives "will not idle at the site unless for the purpose of being serviced, and will not be moved at the site after 10 p.m. except for returning train sets destined for overnight storage at the facility or to initiate early morning service, thus noise at the CMF site will be reduced from former freight yard operating levels." The current CMF daily operations schedule was developed in accordance with this agreement and balanced concerns regarding the impact on the surrounding community with statutory requirements for maintenance.

Other Metrolink Facilities

Metrolink utilizes additional locations to service its trains in the most efficient and effective manner. Specifically, Metrolink has been shifting functions to other locations such as the Stuart Mesa facility in Camp Pendleton and is in the process of expanding its Eastern Maintenance Facility (EMF) in Colton. The EMF is expected to open in 2014.

Upgrading the Locomotive Fleet
Metrolink is the first commuter rail system in the country to procure new Tier 4 locomotives. Metrolink has secured initial funding to purchase up to 20 new low-emission Tier 4 locomotives. In an effort that will benefit all of Southern California, the more fuel efficient Tier 4 locomotives are expected to reduce particulate matter emissions by over 80 percent compared to locomotive engines manufactured before the first Tier 0 standards took effect in 2000. The investment will allow for the removal of pre-Tier 0 locomotives over an approximate three-year period. The project total is not-to-exceed $129.4 million. The first three demonstration locomotives are scheduled to be complete in the fall of 2015.

2.2 Off-Site Sources

To assess off-site emission sources, potential diesel PM sources within one mile of the CMF site boundary were identified. A one-mile distance was chosen because a previous study of diesel PM emissions in the Union Pacific Roseville Railyard (CARB, 2004) indicated that potential cancer risk associated with on-site diesel PM emissions is substantially reduced beyond a one-mile distance from the rail yard. The following off-site sources of diesel PM emissions were identified:

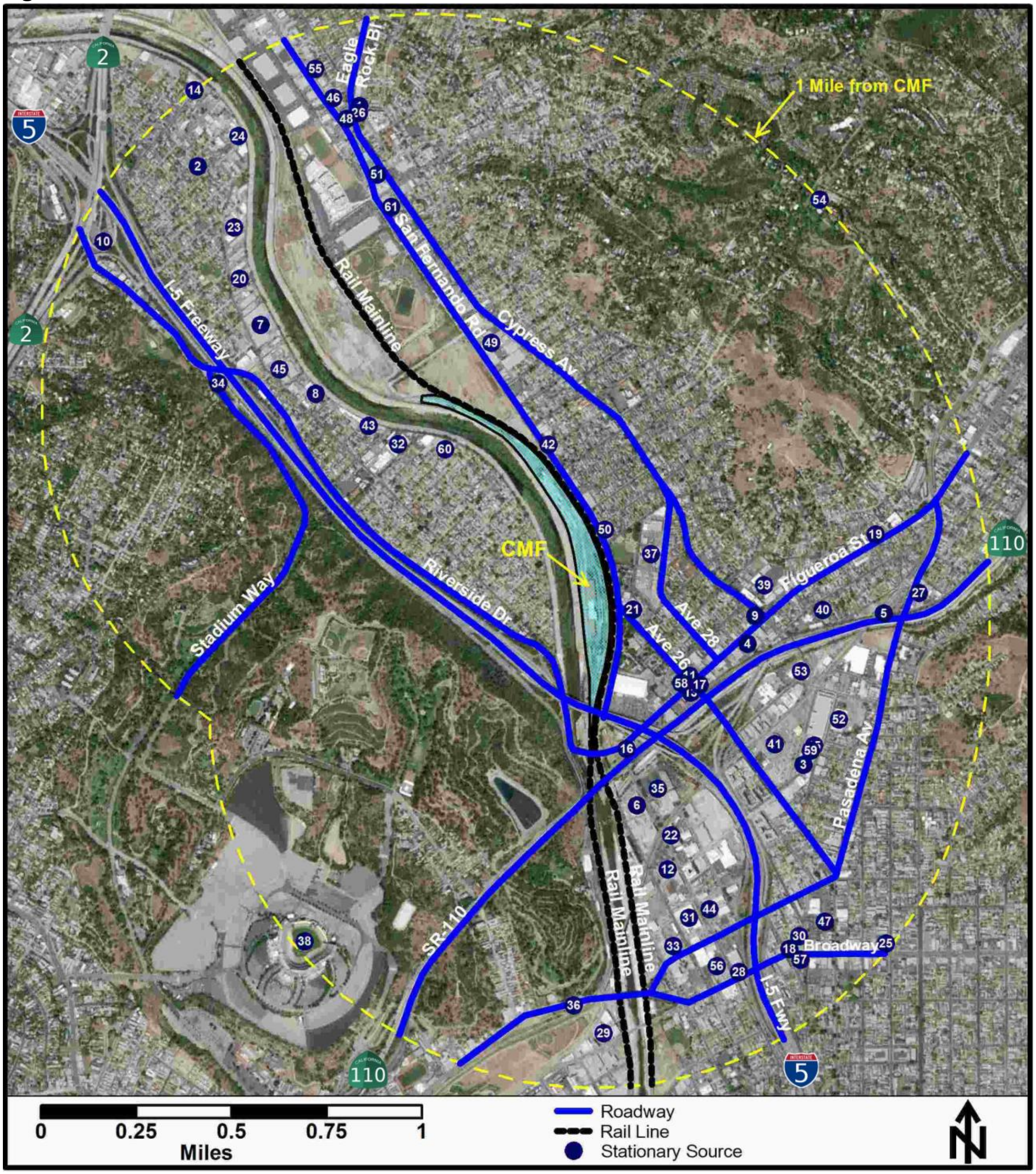
- Diesel trucks traveling on freeways and major surface streets. The roadways included in the emissions assessment are the Interstate 5 (I-5) freeway, State Route 110 (SR-110) freeway, San Fernando Road, Riverside Drive, Figueroa Street, Cypress Avenue, Pasadena Avenue, Stadium Way, West Avenue 26, West Avenue 28, North Broadway, and Eagle Rock Boulevard.

- Trains traveling on the rail mainline that runs adjacent to, north, and south of the CMF. The emissions assessment includes Metrolink, Amtrak, and freight trains. Emissions that occur inside the CMF are excluded from the off-site emissions assessment.

- Stationary sources such as commercial and industrial businesses. There were 61 stationary sources identified within one mile of the CMF through CARB's Facility Search Engine (CARB, 2014) and SCAQMD's Facility Information Detail (FIND) (SCAQMD, 2014c) database searches. A list of these facilities is provided in Appendix C. However, these facilities reported no diesel PM emissions in 2010 or 2012, the most recent emission reporting years. Therefore, stationary sources were not quantified in the off-site sources HRA.

Off-site diesel PM emissions were estimated for the same four operational years as the CMF emissions assessment. The off-site emission sources included in the emissions assessment and HRA are shown in Figure 2-1.

Figure 2-1. Off-Site Sources within One Mile of the CMF



Notes:

1. Off-site sources are limited to one mile from the CMF boundary.
2. See Appendix C for a list of stationary sources by the ID numbers in this figure.

3. Diesel PM Emissions Assessment

Consistent with the CARB rail yard HRAs, this HRA focuses on potential health risks associated with diesel particulate matter exhaust (diesel PM) emissions. CARB identified diesel PM as a toxic air contaminant in 1998 based on its potential to cause cancer and other adverse health problems, including respiratory illnesses and increased risk of heart disease. Subsequent research has shown that diesel PM contributes to premature death (CARB, 2002; 2008; 2010b). Exposure to diesel PM is a health hazard, particularly to children, whose lungs are still developing, and the elderly, who may have other serious health problems. In addition, diesel PM particles are very small. By mass, approximately 94 percent of these particles are less than 2.5 microns in diameter ($PM_{2.5}$). Because of their size, diesel PM particles are readily respirable and can penetrate deep into the lung and enter the bloodstream, carrying with them an array of toxins. Population-based studies in hundreds of cities in the U.S. and around the world demonstrate a strong link between elevated PM levels and premature deaths (Pope et al., 1995, 2002, and 2004; Krewski et al., 2000 and 2009), increased hospitalizations for respiratory and cardiovascular causes, asthma and other lower respiratory symptoms, acute bronchitis, work loss days, and minor restricted activity days (CARB, 2006b).

Diesel PM is the dominant toxic air contaminant in the South Coast Air Basin, which consists of the non-desert portions of Los Angeles, San Bernardino, and Riverside Counties, and all of Orange County. The *Multiple Air Toxics Exposure Study IV* (MATES-IV), conducted by the SCAQMD, showed that approximately 68 percent of the cancer risk from toxic air contaminants in the Basin is attributed to diesel PM (SCAQMD 2014d). Diesel PM is also the dominant toxic air contaminant in and around a rail yard. From a risk management perspective, CARB staff believes it is reasonable to focus an HRA on diesel PM cancer risk because it is the predominant risk driver, and the most effective parameter to evaluate risk reduction actions. Moreover, actions to reduce diesel PM will also reduce non-cancer risks (CARB, 2007).

3.1 CMF Emissions Assessment

The CMF HRA was based on an emissions assessment that was prepared by Metrolink and reviewed by the SCAQMD. A draft emissions assessment was completed in June 2013 and presented to the community on June 27, 2013. In response to comments received from the community, elected officials, and the SCAQMD in late 2013 and early 2014, Metrolink revised and finalized the emissions assessment for use in the HRA. One key revision made in response to public comments was the inclusion of four separate operational years in the HRA: 2010, 2012, 2014, and 2017. Table 3-1 lists the analysis years included in the HRA and describes the CMF emission reduction measures assumed for each year.

Consistent with the CARB rail yard HRAs, the calculation of health risks will assume that the diesel PM emissions for a particular analysis year described above will remain constant, year after year, for the entire exposure period (up to 70 years for cancer risk). This assumption is conservative because emissions will actually decrease with time as locomotives and other diesel equipment will be periodically replaced with newer, cleaner engines as they reach the end of their useful lives.

Table 3-1. CMF Analysis Years Evaluated in the HRA

Operational Year	Environmental Measures Quantified in the CMF Emissions Assessment
2010	• Baseline operating conditions prior to implementation of emission reduction measures.
2012	• Fuel Conservation Program, which consists of: o Trains arrive at CMF with HEP engines off [1] o Trains parked in Storage Yard with both engines shut down until 30 - 45 minutes before departure o Pilot ground power program for use of electric power in rail cars during testing and inspection (9 electric plug in stations) o Increased AESS (Auto-Engine Start/Stop) equipped locomotives from 15 to 32 [2] • Modified CMF yard operations to further reduce time being serviced, noise, and idling
2014	• All of the Operational Year 2012 measures; plus • Reduction in the number of trains serviced at the CMF, from 31 to 26 weekday trains, due to startup of Metrolink's new Eastern Maintenance Facility (EMF) in Colton in the fourth quarter of 2014 • Expanded ground power program (five additional electric plug in stations, for a total of 14) to provide electric power to rail cars during testing and inspection; and • Purchase of a new electric rail car mover to perform yard switching operations
2017	• All of the Operational Year 2014 measures; plus • Replacement of older locomotives with 20 new locomotives meeting the most stringent (Tier 4) emission standards

Notes:

1. Based on actual CMF train arrival data, Metrolink determined that up to 4 percent of trains arrive with their HEP engines running. Therefore, the emissions assessment and HRA assume that 4 percent of trains arrive with HEP engines running.
2. Because of the difficulty in estimating the extent to which the AESS technology automatically shuts down locomotive main engines at the CMF, the emissions assessment and HRA conservatively assume no reduction in idling times due to AESS technology.

3.1.1 CMF Emission Calculation Methodology

All locomotives and nearly all yard support equipment at the CMF use diesel fuel and therefore generate diesel PM emissions. The emissions assessment prepared for the CMF HRA covers all sources of diesel PM emissions at the CMF, including:

- Locomotive main engines – used during fueling, servicing, inspection, brake testing, car cleaning, load testing, yard switching, idling, and train movement throughout the yard.
- Locomotive head-end power (HEP) engines – used to provide electricity to the rail cars while not connected to ground power, and during maintenance load tests.
- Diesel yard equipment – includes two emergency generators, two forklifts, a welder, and a diesel rail car mover used to perform switching activities in lieu of locomotives.
- On-Road Diesel Trucks – includes fuel and vendor delivery trucks while on CMF property.

The general operational assumptions used in the CMF emissions assessment are presented in Table 3-1. These assumptions are summarized from a more extensive set of operational data developed by Metrolink and included in Appendix B. The following paragraphs describe the emission calculation methodology by source type.

Table 3-1. Operational Assumptions for the CMF

Activity	Units	Analysis Year			
		2010	2012	2014	2017
Train Operations					
Annual No. of Trains at CMF [1]	trains/yr	8,239	8,239	6,935	6,935
Avg. Time of Locomotive Idling and Brake Test	min/train	299	171	164	164
Avg. HEP Engine Run Time [2]	min/train	285	96	86	86
Avg. Time of Internal Train Movements	min/train	31	31	29	29
Switching					
Switching Performed by Locomotive	hr/yr	240	240	90	90
Switching Performed by Diesel Rail Car Mover [3]	hr/yr	1,760	1,760	150	150
Load Testing					
Annual No. of Locomotive Load Tests [4]	tests/yr	312	312	312	312
Annual No. of HEP Engine Load Tests [5]	tests/yr	312	312	312	170
Diesel Truck Visits					
Fuel Trucks [6]	trucks/yr	276	276	156	156
Miscellaneous Delivery Trucks	trucks/yr	260	260	260	260
Diesel Yard Equipment Usage					
Standby Generators (combined usage)	hr/yr	47	47	47	47
Forklifts (combined usage)	hr/yr	240	240	240	240
Welder	hr/yr	180	180	180	180

Notes:

1. For purposes of calculating on-site CMF emissions, one train is defined as entering the CMF at the south end (arriving from Union Station), being serviced and stored at the CMF, and departing the CMF at the south end (departing to Union Station). This is counted as one train even though it arrives and departs with a different Metrolink train ID number.
2. The use of ground power during train service and inspection substantially reduces the HEP engine run times starting in 2012.
3. The electric rail car mover performs the majority of switching activities starting in 2014, thereby reducing diesel equipment usage.
4. A locomotive load test lasts an average of 50 minutes.
5. A HEP engine load test lasts an average of 30 minutes.
6. Starting in 2014, fuel trucks that fuel locomotives at remote sites (outside the CMF) will no longer take on fuel at the CMF, thereby reducing the number of fuel truck visits.

Locomotive Main Engines

Currently, Metrolink has 52 passenger locomotives in its fleet. Twenty-two (22) of the locomotives – consisting of 15 model MP36PH-3C and 7 model 59PH repowered locomotives – meet national Tier 2 engine exhaust standards (U.S. EPA, 2009). The remaining 30 locomotives – consisting of 15 model F59PH, 14 model F59PHI, and 1 model F40PH locomotives – have pre-Tier 0 engines, meaning they were manufactured before the U.S. EPA's 4-tiered engine exhaust standards took effect in 2000. The CMF emissions assessment assumed that Metrolink's locomotive fleet will remain as described above for 2010, 2012, and 2014 conditions.

In 2017, the emissions assessment assumes that 20 new model F125 locomotives, meeting the most stringent Tier 4 engine exhaust standards, will join the fleet. Tier 4 locomotives are expected to reduce diesel PM emissions by over 80 percent compared to pre-Tier 0 locomotives. Metrolink anticipates that the 20 new F125 locomotives will replace 20 pre-Tier 0 locomotives, including 10 F59PH, nine F59PHI, and one F40PH locomotives. Metrolink expects that, on average, at least 12 of the 26 weekday trains at the CMF will use F125 locomotives, resulting in a Tier 4 locomotive on at least 46 percent of the trains at the CMF.

Diesel PM emissions from locomotive main engines at the CMF were calculated by grouping activity into the following five categories:

- Train Idling – During 2010, before implementation of the fuel conservation program, all locomotives on trains were assumed to idle continuously while at the CMF, except when operating at higher throttle settings during train movement and brake testing. Starting in 2012, after implementation of the fuel conservation program, locomotive engines are turned off during portions of their stay at the CMF, and idling is generally limited to specific events. For example, upon arrival, some trains idle temporarily on the River Track until positions become available on the S&I tracks. Idling also occurs during fueling on the S&I tracks; and during servicing, testing, and inspection on the S&I and storage tracks. Incidental idling occurs during the repositioning of trains within the CMF unless the rail car mover is used. Idling is also necessary prior to departure from the CMF when additional testing and inspection are required.

  The MP36PH-3C, 59PH repowered, F59PH, and F59PHI locomotives all idle at the idle throttle setting. The F40PH and the F125 locomotives do not have separate HEP engines; therefore, their main engines must idle at higher throttle settings to provide sufficient additional power for the railcars when such power is needed (for example, during inspection, car cleaning, and prior to departure to condition the air inside the railcars). When providing railcar power, the F40PH must idle at the highest throttle setting, notch 8, to provide the proper engine revolutions per minute (RPMs) for electric power production. The F125 locomotives have a more advanced power production technology and therefore will only need to idle at notch 1 when producing electric power to the railcars. When electric power is not needed for the railcars (for example, upon train arrival, during refueling, train repositioning, and when ground power is used), the F40PH and F125 locomotives idle at the idle throttle setting.

  Because of the difficulty in estimating the extent to which the AESS technology automatically shuts down locomotive main engines at the CMF, the emissions assessment and HRA conservatively assume no reduction in idling times due to AESS technology.

- Train Movement – While at the CMF, each train will typically undergo several movements. The first movement occurs when the train enters the CMF at the south end and proceeds north on the River Track. Once inside the CMF, the train will typically move to the fueling area on the S&I tracks and remain there for service and inspection, or move to another location on the S&I or storage tracks for service and inspection. The train may also be repositioned within the CMF one or more times during storage to streamline the dispatch of departing trains. Finally, the train will depart the CMF at the south end. To improve the accuracy of the emission calculations, Metrolink tracked the movements of three trains through the CMF and prepared a composite duty cycle for train movements for use in the emissions assessment. The duty cycle provides the time that the locomotives spend at each throttle setting, which ranged from idle to as high as notch 6. This duty cycle was used in the emissions assessment for all train movements within the CMF except in cases where models F40PH and F125 are providing electric power to the railcars. In these cases, the F40PH locomotive was assumed to run at notch 8, and the F125 locomotives were assumed to run at notch 1 instead of idle (all other throttle settings are unchanged from the composite duty cycle).

- Brake Testing – Federal regulations require that each train undergoes an air brake test while at the CMF. To improve the accuracy of the emission calculations, Metrolink tracked the locomotive activity during six separate brake tests and prepared a composite duty cycle for brake tests for use in the emissions assessment. The duty cycle provides the time that the locomotives spend at each throttle setting, which ranged from idle to as high as notch 5. The average air brake test lasted 26 minutes, of which 15 minutes was spent idling and 11 minutes was spent at higher throttle settings. This duty cycle was used in the emissions assessment for all train movements within the CMF except in cases where models F40PH and F125 are providing electric power to the railcars. In these cases, the F40PH locomotive was assumed to run at notch 8, and the F125 locomotives were assumed to run at notch 1 instead of idle (all other throttle settings are unchanged from the composite duty cycle).

- Load Testing – After repairs, locomotives are connected to a load bank just north of the locomotive shop and run at a range of throttle settings to test performance. A load test lasts an average of 50 minutes and tests all throttle settings from notch 1 to 8. The locomotive models are assumed to be load tested in proportion to their fleet population.

- Switching – Each day, between about 4 p.m. and 10 p.m., yard switching takes place at the CMF to optimize train positions for an efficient dispatch of departing trains, and to assemble and disassemble trains if necessary. Switching is normally performed with the diesel railcar mover. However, locomotives are used for switching approximately 40 days per year when the railcar mover is down for maintenance. Starting in 2014, the electric railcar mover began operating, with the diesel railcar mover serving as first backup and locomotives serving as second backup. This reduced locomotive switching to approximately 15 days per year. Metrolink provided the duty cycle for CMF switching, which includes throttle settings ranging from idle to notch 3. Switching is performed by the F59PH, F59PHI, F40PH, and 59PH repowered locomotives.

Diesel PM emission factors by throttle setting were determined for each Metrolink locomotive model using available engine test data from the U.S. EPA (1998; 2013b), Southwest Research Institute (2013), and Wabtec (2013). The emission factors were applied to the annual activity levels and duty cycles associated with each activity category described above to determine the diesel PM emission rates for each analysis year. By-notch emission factors for the F125 locomotive model are proprietary and were provided by Progress Rail Services Corporation directly to the SCAQMD under a confidentiality agreement. As a result, the emission calculations for the F125 locomotives in 2017 were performed by the SCAQMD and provided to Metrolink with the underlying emission factors and formulas removed. Therefore, the emission calculations in Appendix B are provided for all locomotive models except the F125.

Locomotive HEP Engines

Currently, 51 of the 52 passenger locomotives in Metrolink's fleet have HEP engines. The HEP engines are used to supply electric power to the railcars. The F40PH locomotive does not have a HEP engine; instead, the main engine supplies both propulsion power and electric power to the railcars. The 20 F125 locomotives scheduled to join the fleet in 2017 also will not have HEP engines.

Metrolink's HEP engine fleet consists of 33 Caterpillar C27 engines that meet national Tier 2 nonroad engine exhaust standards, 4 Caterpillar C3412 engines that meet national Tier 1 standards, and 14 Caterpillar C3406 engines that were manufactured before the nonroad engine standards took effect (U.S. EPA, 1998b). According to the emission calculations for the HEP engines in Appendix B, on a per-hp-hr basis, the Tier 2 C27 engine has approximately 20 percent lower diesel PM emissions than the Tier 1 C3412 engine, and approximately 80 percent lower diesel PM emissions than the unclassified C3406 engine. For the CMF emissions assessment, this HEP engine fleet was assumed to remain unchanged in 2010, 2012, and 2014. In 2017, when the F125 locomotives enter the fleet, 19 HEP engines will be removed from the fleet, including all of the C3406 and C3412 engines. The remaining HEP engine fleet will consist of 32 Tier 2 C27 engines.

In 2010, HEP engines ran nearly continuously while on trains at the CMF. As shown in Table 3-1, the fuel conservation program substantially reduced HEP engine run times in 2012, 2014, and 2017. With the fuel conservation program, the HEP engines are normally turned off when trains enter the CMF. Based on actual CMF train arrival data, Metrolink determined that up to 4 percent of trains arrive with their HEP engines running. Therefore, the emissions assessment and HRA assume that 4 percent of trains arrive with HEP engines running in 2012, 2014, and 2017. Once inside the CMF, the HEP engines are normally only turned on when it is necessary to provide electric power to the rail cars. HEP power is typically needed during testing and inspection, car cleaning (when ground power is not available), and prior to departure for heating or air conditioning.

HEP engines are also load-tested after preventative maintenance and repairs. The load tests are performed just north of the locomotive shop. A load test lasts an average of 30 minutes and tests a range of power settings. The HEP engines are assumed to be load tested in proportion to their fleet population.

Diesel PM emission factors for the three HEP engine models at the CMF were obtained from the CARB's 2011 Inventory Model for In-Use Off-Road Equipment (CARB, 2013c). The emission factors were applied to the annual HEP engine activity levels to determine the diesel PM emission rates for each analysis year.

Diesel Yard Equipment
Metrolink has a small fleet of diesel yard equipment to support operations at the CMF. The equipment consists of two standby generators to provide power in the event of an outage, two forklifts and a welder used in the maintenance and repair of locomotives and rail cars, and a diesel rail car mover used to perform switching in lieu of locomotives. Annual usage of the standby generators, forklifts, and welder was assumed to be constant for all four analysis years. Annual usage of the diesel rail car mover was assumed to be reduced substantially starting in 2014, as the electric rail car mover begins operating as the primary switcher and the diesel rail car mover is given a backup role.

Diesel PM emission factors for the yard equipment at the CMF were obtained from the CARB's 2011 Inventory Model for In-Use Off-Road Equipment (CARB, 2013c). The emission factors were applied to the annual yard equipment activity levels to determine the diesel PM emission rates for each analysis year.

On-Road Diesel Trucks
Approximately 156 fuel trucks per year deliver diesel fuel to the CMF. In 2010 and 2012, an additional 120 fuel trucks per year filled up with fuel at the CMF and delivered it to remote Metrolink sites. However, this practice was discontinued after 2012, as an outside service was used to deliver fuel to remote sites without visiting the CMF. Another 260 trucks visit the CMF each year to deliver parts and supplies.

Diesel PM emission factors for on-road trucks at the CMF were obtained from the CARB's EMFAC2011 program (CARB, 2012). The emission factors were applied to the annual truck on-site idling times and driving distances to determine the diesel PM emission rates for each analysis year.

3.1.2 CMF Summary of Emissions

Table 3-2 summarizes the diesel PM emissions occurring within CMF boundaries in 2010, 2012, 2014, and 2017. The emissions decline substantially with each successive analysis year. Emissions in 2012, after implementation of the fuel conservation program and modified yard operations, are 44 percent less than 2010. Emissions in 2014, after a reduction in the number weekday trains, an expanded ground power program, and purchase of a new electric rail car mover, are 56 percent less than 2010. Emissions in 2017, after the purchase of 20 new Tier 4 locomotives, are 79 percent less than 2010.

The primary and secondary sources of diesel PM emissions at the CMF are locomotive main and HEP engines, respectively. Emissions from yard equipment and on-site trucks are minor by comparison.

Table 3-2. Diesel PM Emissions Associated with the CMF

Emission Source	Emission Rate (ton/yr)			
	2010	2012	2014	2017
Locomotives	**2.12**	**1.42**	**1.16**	**0.60**
Idling	1.25	0.60	0.48	0.18
Train Movement within the CMF	0.39	0.35	0.28	0.16
Brake Test	0.34	0.34	0.28	0.18
Load Testing	0.12	0.12	0.12	0.07
Switching	0.02	0.02	0.01	0.01
HEP Engines	**1.42**	**0.51**	**0.39**	**0.14**
HEP Engines on Trains	1.40	0.50	0.38	0.13
Load Testing	0.01	0.01	0.01	0.005
Yard Equipment	**0.06**	**0.06**	**0.02**	**0.02**
Diesel Rail Car Mover	0.05	0.05	0.004	0.005
Generators, Forklifts, Welder	0.01	0.01	0.01	0.01
Trucks On-Site	**0.003**	**0.002**	**0.001**	**0.0001**
Total	**3.60**	**2.00**	**1.58**	**0.76**
Change Relative to 2010	**--**	**-44%**	**-56%**	**-79%**

Notes:

1. Emissions occur within the CMF boundary.

3.2 Off-Site Sources Emissions Assessment

As described in Section 2.2, trucks, trains, and commercial and industrial facilities (i.e., stationary sources) were identified as off-site sources that potentially contribute to human health risks in the communities surrounding the CMF. To determine the diesel PM emissions, Metrolink collected available activity and emissions data for off-site sources within one mile of the CMF boundary. The calculation methodology and emissions associated with off-site trucks and trains are described below. The complete calculation tables for off-site sources are included in Appendix C.

Sixty-one stationary sources were identified within one mile of the CMF through CARB (2014) and SCAQMD (2014c) records searches. A list of these facilities is provided in Appendix C. However, these facilities reported no diesel PM emissions in 2010 or 2012, the most recent emission reporting years. Therefore, stationary sources were not quantified in the off-site sources HRA. Although some stationary sources may produce elevated health risks in their immediate vicinities, they are not expected to be major health risk contributors on a broader geographical scale, as the MATES-IV study shows that mobile on-road and mobile off-road sources contribute 92 percent of the cancer risk in the South Coast Air Basin (SCAQMD, 2014d). Therefore, the health risks associated with off-site trucks and trains are expected to provide a reasonable estimate of the health risks associated with off-site sources within one mile of the CMF.

3.2.1 Off-Site Source Emission Calculation Methodology

The general operational assumptions used in the off-site sources emissions assessment are presented in Table 3-3. The following paragraphs describe the emission calculation methodology by source type.

Table 3-3. Operational Assumptions for Off-Site Sources within One Mile of the CMF

Activity	Units	Analysis Year			
		2010	2012	2014	2017
Diesel Truck Travel on Freeways and Surface Streets					
I-5 south of SR-110	truck trips/day	13,125	14,411	14,491	14,606
I-5 north of SR-110	truck trips/day	13,128	14,428	14,508	14,623
SR-110 south of I-5	truck trips/day	1,747	1,673	1,682	1,696
SR-110 north of I-5	truck trips/day	988	935	940	948
Eagle Rock Boulevard	truck trips/day	1,300	1,307	1,315	1,325
Pasadena Ave	truck trips/day	586	589	592	597
San Fernando Road	truck trips/day	503	506	509	513
Figueroa Street	truck trips/day	486	489	491	495
W Ave 26	truck trips/day	386	388	390	393
Cypress Ave	truck trips/day	333	335	337	340
Riverside Drive	truck trips/day	286	288	290	292
Stadium Way	truck trips/day	198	199	200	202
W Ave 28	truck trips/day	167	168	168	170
North Broadway	truck trips/day	49	50	50	50
Train Travel on Mainlines					
Metrolink Trains north of I-5	trains/yr	16,842	16,842	16,842	16,842
Metrolink Trains south of I-5	trains/yr	33,841	33,841	33,841	33,841
Amtrak Trains north and south of I-5	trains/yr	4,380	4,380	4,380	4,380
Freight Trains north and south of I-5	trains/yr	2,509	2,509	2,509	2,509

Notes:

1. Trucks include all vehicles with three or more axles, except buses, and two-axle vehicles with dual rear tires. Pickup trucks and RVs with dual rear tires are classified as trucks (Caltrans 2014).
2. SR-110 truck volumes are small compared to I-5 because SR-110 restricts commercial vehicles over 6,000 pounds.
3. Train counts are one-way; i.e., a train round trip would count as two trains in this table.

On-Road Diesel Trucks

Trucks, as defined by Caltrans, include all vehicles with three or more axles, except buses, and two-axle vehicles with dual rear tires. Average daily truck volumes on I-5 and SR-110 were obtained from the Caltrans 2010 and 2012 Traffic Census (Caltrans, 2014). Average truck speeds on I-5 and SR-110 were obtained from Caltrans Performance Measurement System (PeMS) data (Caltrans, 2013). Average daily truck volumes on surface streets were obtained from the SCAG travel demand model, LADOT traffic counts, and Metro traffic counts, as provided by Iteris (2014). An average truck travel speed of 20 miles per hour was used for all surface streets (Iteris, 2014). Annual growth rates from Metro's 2010 Congestion Management Program (Metro, 2010) were applied to all truck volumes to estimate the growth in traffic from 2010 to 2017.

Diesel PM emission factors for off-site trucks were obtained from the CARB's EMFAC2011 program (CARB, 2012). The emission factors were applied to the annual truck vehicle miles traveled (VMT) on each roadway to determine the diesel PM emission rates for each analysis year.

Passenger and Freight Trains

The rail mainline that runs north-south through the HRA study area and adjacent to the CMF (Figure 2-1) is used by Metrolink, Amtrak, and freight trains. Metrolink provided annual train counts, average travel speeds, and locomotive engine throttle settings for its trains traveling on the mainline north of I-5 and the two mainlines south of I-5 (one on each side of the L.A. River). Metrolink estimates that, south of I-5, approximately 75 percent of Metrolink and Amtrak trains use the rail mainline on the west bank of the L.A. River, and approximately 25 percent of Metrolink and Amtrak trains and all freight trains use the rail mainline on the east bank of the L.A. River. Metrolink trains north of I-5 consist of trains running on their passenger routes between Union Station and outlying passenger stations. Metrolink trains south of I-5 include these same passenger trains plus the CMF trains traveling without passengers between Union Station and the CMF for servicing. Annual train counts for Amtrak were obtained from current Amtrak train schedules for the Coast Starlight and Pacific Surfliner (Amtrak 2014). Amtrak trains were assumed to travel at the same average speeds and locomotive engine throttle settings as Metrolink passenger trains. The percentage of Metrolink locomotives with HEP engines was assumed to be representative of its system-wide locomotive fleet in each analysis year. All Amtrak trains were conservatively assumed to have a HEP engine.

Similar to the emission calculations for the CMF, diesel PM emission factors for off-site Metrolink locomotives traveling within one mile of the CMF were based on engine test data from the U.S. EPA (1998; 2013b), Southwest Research Institute (2013), and Wabtec (2013). Emission factors for the F125 locomotive model are proprietary and were provided by Progress Rail Services Corporation directly to the SCAQMD under a confidentiality agreement. Therefore, the emission calculations in Appendix C are provided for all locomotive models except the F125. Diesel PM emission factors for the Metrolink HEP engines were obtained from the CARB's 2011 Inventory Model for In-Use Off-Road Equipment (CARB, 2013c). The locomotive and HEP emission factors were applied to the annual off-site activity levels within one mile of the CMF to determine the diesel PM emission rates for each analysis year.
The locomotive and HEP emission factors used for the off-site Metrolink trains were also assumed to be representative of Amtrak trains in 2010, 2012, and 2014. However, in 2017, the Metrolink emission factors will be substantially reduced with the introduction of 20 Tier 4 F125 locomotives and the retention of only the Tier 2 C27 HEP engines in the fleet. Therefore, the 2017 emissions assessment for Amtrak trains conservatively used 2014 Metrolink emission factors.

Annual train counts, average travel speeds, and locomotive engine throttle settings for freight trains on the mainline were derived from the *Toxic Air Contaminant Emission Inventory and Dispersion Modeling Report for the Los Angeles Transportation Center* (UPRR, 2007). The Los Angeles Transportation Center (LATC), or "Piggyback Yard", is an intermodal rail yard located about 1 ½ miles south of the CMF and was one of the 17 rail yards for which HRAs were performed by CARB. Diesel PM emission factors representative of the national line haul locomotive fleet were obtained from the U.S. EPA (2009). The emission factors were adjusted to the specific engine throttle settings for this study using notch-specific data from the U.S. EPA (1998). The locomotive emission factors were applied to the annual off-site activity levels within one mile of the CMF to determine the diesel PM emission rates for each analysis year.

3.2.2 Off-Site Sources Summary of Emissions

Table 3-4 summarizes the off-site diesel PM emissions occurring within one mile of the CMF in 2010, 2012, 2014, and 2017. The emissions decline substantially with each successive analysis year. The decline in off-site diesel PM emissions is primarily in response to the *Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants from In-Use On-Road Diesel-Fueled Vehicles* (CARB, 2010), which requires the phase-in of diesel particulate filters and stricter engine emission standards on heavy duty diesel trucks from 2012 to 2023. Normal fleet turnover, whereby older trucks and line haul locomotives reach the end of their useful lives and are replaced with newer, cleaner vehicles, also contributes to the decline in off-site emissions.

The primary source of off-site diesel PM emissions within one mile of the CMF is trucks, particularly on I-5. Trucks on I-5 contribute 69 to 83 percent of the total off-site diesel PM emissions, depending on the analysis year.

Table 3-4. Diesel PM Emissions Associated with Off-Site Sources within One Mile of the CMF

Emission Source	Emission Rate (ton/yr)			
	2010	2012	2014	2017
Trucks	**4.99**	**4.29**	**1.97**	**1.26**
I-5 Freeway	4.81	4.15	1.88	1.21
SR-110 Freeway	0.03	0.02	0.02	0.01
Surface Streets	0.15	0.12	0.07	0.03
Trains	**0.83**	**0.80**	**0.78**	**0.49**
Metrolink	0.47	0.47	0.47	0.23
Amtrak	0.10	0.10	0.10	0.10
Freight	0.26	0.22	0.20	0.16
Total	**5.82**	**5.09**	**2.74**	**1.75**
Change Relative to 2010	**--**	**-13%**	**-53%**	**-70%**

Notes:

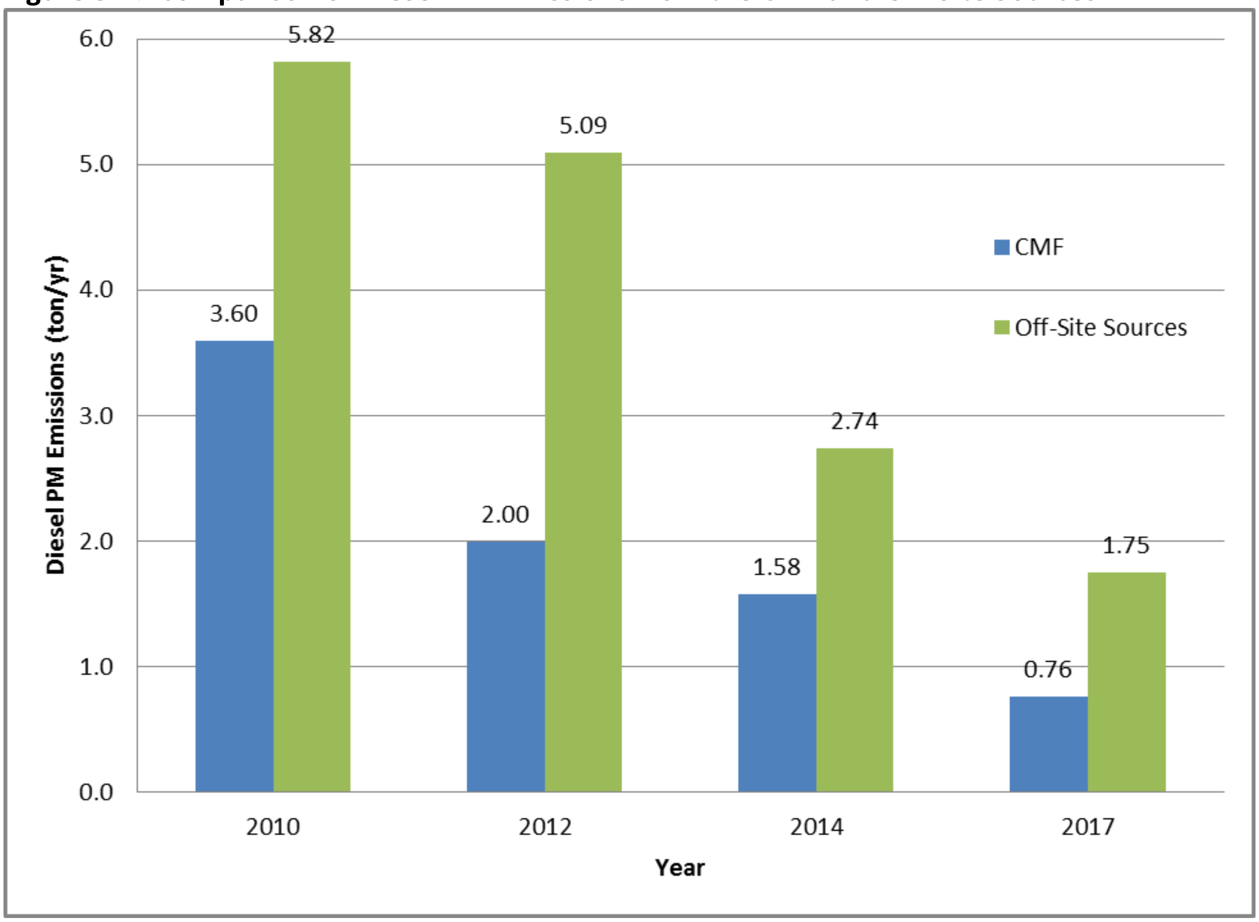
1. Surface streets include San Fernando Rd., Riverside Dr., Figueroa St., Cypress Ave., Pasadena Ave., Stadium Way, W. Ave. 26, W. Ave. 28, N. Broadway, and Eagle Rock Blvd.
2. Train emissions occur on the mainline and include locomotive main engines and HEP engines (where applicable).
3. Metrolink train emissions exclude emissions within the CMF.

3.3 Comparison of Emissions from the CMF and Off-Site Sources

Figure 3-1 summarizes the diesel PM emissions from the CMF and off-site sources for the four operational years of the emissions assessment. The chart shows that the CMF emissions are significantly less than the off-site source emissions within one mile of the CMF for each of the four analysis years. The chart also shows that both the CMF and off-site emissions will decline substantially from 2010 to 2017.

The CMF's diesel PM emissions constituted 38 percent of the total CMF plus off-site source emissions in 2010. By 2017, the CMF's diesel PM emissions will be reduced to 30 percent of the total emissions. The CMF emissions are predicted to decline 79 percent from 2010 to 2017 in response to the voluntary emission reduction measures implemented by Metrolink. The off-site diesel PM emissions will decline 70 percent from 2010 to 2017 due to regulatory requirements and fleet turnover.

Figure 3-1. Comparison of Diesel PM Emissions from the CMF and Off-Site Sources



Notes:

1. CMF emissions occur on-site.
2. Off-Site Source emissions occur within one mile of the CMF.

4. Air Dispersion Modeling

4.1 Air Dispersion Model Selection

The U.S. EPA dispersion model, AERMOD v. 14134 (U.S. EPA, 2014) was used to estimate concentrations of diesel PM in the air resulting from CMF and off-site source emissions. AERMOD is recommended by the EPA as the preferred air dispersion model, and is the recommended model in CARB's *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (CARB, 2006).

In accordance with SCAQMD recommendations (SCAQMD, 2014b), AERMOD was run with five years of hourly meteorological data from the SCAQMD's Central Los Angeles (CELA) site (SCAQMD, 2014). The resulting five-year average diesel PM concentrations predicted by AERMOD in the affected communities were used in the health risk calculations described in Section 5. Consistent with SCAQMD modeling guidance (SCAQMD, 2013), other key model options include use of the urban dispersion algorithm and elevated terrain processing.

4.2 Emission Source Representation

The CMF and off-site sources were simulated in AERMOD as a collection of point, area, and line sources positioned where the activity and emissions regularly take place. Point sources are used to represent stacks or other fixed-location sources that release emissions in a plume with upward momentum and thermal buoyancy. Area sources are used to represent emissions that are spread out over a relatively large geographical area. Line sources are used to represent emissions that occur along well-defined paths, such as rail lines or roads. Unlike point sources, area and line sources have no upward plume momentum or thermal buoyancy in AERMOD. Sections 4.2.1 and 4.2.2 describe the development of the AERMOD source parameters for the CMF and off-site sources, respectively.

Each emission source in AERMOD was assigned an annual diesel PM emission rate as determined by the emissions assessment. The sources were also assigned diurnal emission profiles to simulate the daily ebb and flow of activity and emissions at the CMF and for the off-site sources. The diurnal emission profiles are included in Appendix D. Appendix D also includes diagrams showing the physical locations of the AERMOD sources, and the specific source parameters used in AERMOD.

4.2.1 Source Parameter Development for the CMF

Locomotive Main Engines

Locomotive idling, brake testing, and load testing occur while the locomotive is stationary. Therefore, emissions from these activities were modeled in AERMOD as point sources. The stack release height, diameter, exit velocity, and exit temperature were obtained from the Roseville Rail Yard Study (CARB, 2004) for the locomotive engine model most representative of the Metrolink locomotive fleet at the appropriate engine throttle settings. The values for exit velocity and exit temperature for the brake test and load test were averaged using time-in-notch duty cycles provided by Metrolink. The effects of building downwash, whereby exhaust plumes are affected by the aerodynamic wakes caused by buildings, were accounted for in AERMOD.

The modeled buildings include prominent buildings at the CMF as well as the locomotives themselves.

Locomotives moving on trains while at the CMF were modeled in AERMOD as line sources. Locomotives performing switching at the CMF were modeled in AERMOD as area sources because the travel paths taken by the switchers are less defined than the paths taken by trains. Because line and area sources do not account for the upward momentum and thermal buoyancy of the locomotive exhaust plume, the plume rise was estimated using a procedure developed for the Roseville Rail Yard Study (CARB, 2004) and used in the CARB Rail Yard HRAs. The procedure involves using the U.S. EPA SCREEN3 dispersion model (U.S. EPA, 2013) as a plume rise calculator, where the wind speed in SCREEN3 is set equal to the average locomotive travel speed. The SCREEN3 values for stack exit velocity and exit temperature were averaged using time-in-notch duty cycles provided by Metrolink. The effects of building downwash from the locomotive were accounted for in SCREEN3. Consistent with the Roseville Rail Yard Study, separate plume rise calculations were done for daytime (6:00 a.m. to 6:00 p.m.) and nighttime (6:00 p.m. to 6:00 a.m.) conditions because the atmosphere is much more stable at night, resulting in a significantly higher final plume height at night. The final plume heights for daytime and nighttime conditions calculated by SCREEN3 were then used as the line and area source release heights in AERMOD. Appendix D provides additional details on the development of plume heights for sources in motion.

Locomotive HEP Engines
HEP engine emissions that occur while the locomotive is stationary were modeled in AERMOD as point sources. The stack release height, diameter, exit velocity, and exit temperature were provided by Metrolink and Caterpillar (2014) for normal and load test operating conditions. The effects of building downwash were accounted for in AERMOD. The modeled buildings include prominent buildings at the CMF as well as the locomotives themselves.

HEP engine emissions that occur while the train is moving were modeled in AERMOD as line sources. Because line sources do not account for the upward momentum and thermal buoyancy of the HEP engine exhaust plume, the plume rise was estimated using SCREEN3, as described above for locomotive main engines. The final plume heights for daytime and nighttime conditions calculated by SCREEN3 were then used as the line source release heights in AERMOD.

Diesel Yard Equipment
The two standby generators at the CMF were modeled as point sources. The stack release heights and diameters were provided by Metrolink. The stack exit temperatures and exhaust flow rates (used to derive the exit velocities) were provided by Cummins (2000; 2006). Because the standby generators have rain caps on top of their stacks, they were modeled in AERMOD using the rain cap beta option. With this option, AERMOD adjusts the stack parameters to account for the inhibited plume rise due to the plume deflection caused by the rain caps. The effects of building downwash were accounted for in AERMOD. The modeled buildings include prominent buildings at the CMF as well as the locomotives themselves.

The diesel forklifts and welder were modeled as area sources because they are moved around as needed at the CMF. Consistent with the CARB Rail Yard HRAs, this equipment was modeled using a release height obtained from the CARB *Diesel Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (CARB, 2000).

The diesel rail car mover was modeled in AERMOD as area sources covering the same locations as the locomotives performing switching. The source parameters for the rail car mover were provided by Metrolink. Because area sources do not account for the upward momentum and thermal buoyancy of the engine exhaust plume, the plume rise was estimated using SCREEN3, as described above for locomotive main engines. The final plume heights for daytime and nighttime conditions calculated by SCREEN3 were then used as the area source release heights in AERMOD.

On-Road Diesel Trucks
Diesel trucks driving at the CMF were modeled as line sources. Consistent with the CARB Rail Yard HRAs, trucks were modeled using a release height obtained from the CARB *Diesel Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (CARB, 2000).

4.2.2 Source Parameter Development for Off-Site Sources

On-Road Diesel Trucks
Diesel trucks driving on freeways and major streets within one mile of the CMF were modeled as line sources. Consistent with the CARB Rail Yard HRAs, trucks were modeled using a release height obtained from the CARB *Diesel Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (CARB, 2000).

Passenger and Freight Trains
Metrolink, Amtrak, and freight trains traveling on the mainlines within one mile of the CMF were modeled as line sources. Because line sources do not account for the upward momentum and thermal buoyancy of the locomotive exhaust plumes, the plume rise was estimated using SCREEN3, as described above for locomotive main engines in Section 4.2.1. For Metrolink trains, the SCREEN3 values for stack exit velocity and exit temperature were averaged using time-in-notch duty cycles provided by Metrolink. The final plume heights for daytime and nighttime conditions calculated by SCREEN3 were then used as the line source release heights in AERMOD. Amtrak trains were modeled with the same line source parameters as Metrolink trains. Freight trains were modeled with the source release heights determined by SCREEN3 in the Roseville Rail Yard Study (CARB, 2004) and used in the CARB Rail Yard HRAs (CARB, 2007).

4.3 Meteorological Data

Pre-processed meteorological data were obtained from the SCAQMD for use in AERMOD (SCAQMD 2014). As recommended by the AQMD (2014b), data from the Central Los Angeles (CELA) station were used for the dispersion modeling for the CMF and off-site sources. The CELA station is located at 1630 North Main Street, Los Angeles, CA 90012. Of the AQMD's 27 sites with available meteorological data, the CELA station is closest to the CMF. It is located approximately 1 ¼ miles south of the CMF's southern boundary. The location of the CELA station relative to the CMF is shown in Figure 4-1.

Figure 4-1. CELA Meteorological Station Location

The meteorological data set for CELA consists of consecutive hourly observations for the following five calendar years deemed representative of climatological norms by the AQMD: 2006, 2007, 2009, 2010, and 2011. The AQMD processed the data using the U.S. EPA programs AERSURFACE v. 13016 and AERMET v. 12345 (SCAQMD 2014).

Appendix D includes a wind rose for the CELA station. A wind rose is a figure showing the frequency of wind speeds and directions measured at the station. The wind rose shows that the predominant wind direction at the CELA station is from the west-southwest (onshore), and a secondary wind direction is from the northeast (offshore).

4.4 Modeled Receptors

A receptor is a geographical point at which AERMOD calculates a diesel PM concentration and health risks are quantified. Five sets of receptors were used for the CMF and off-site sources HRA: a fine grid, a medium grid, a coarse grid, sensitive receptors, and census block centroids. The modeled receptors were developed in accordance with CARB guidelines (2006).

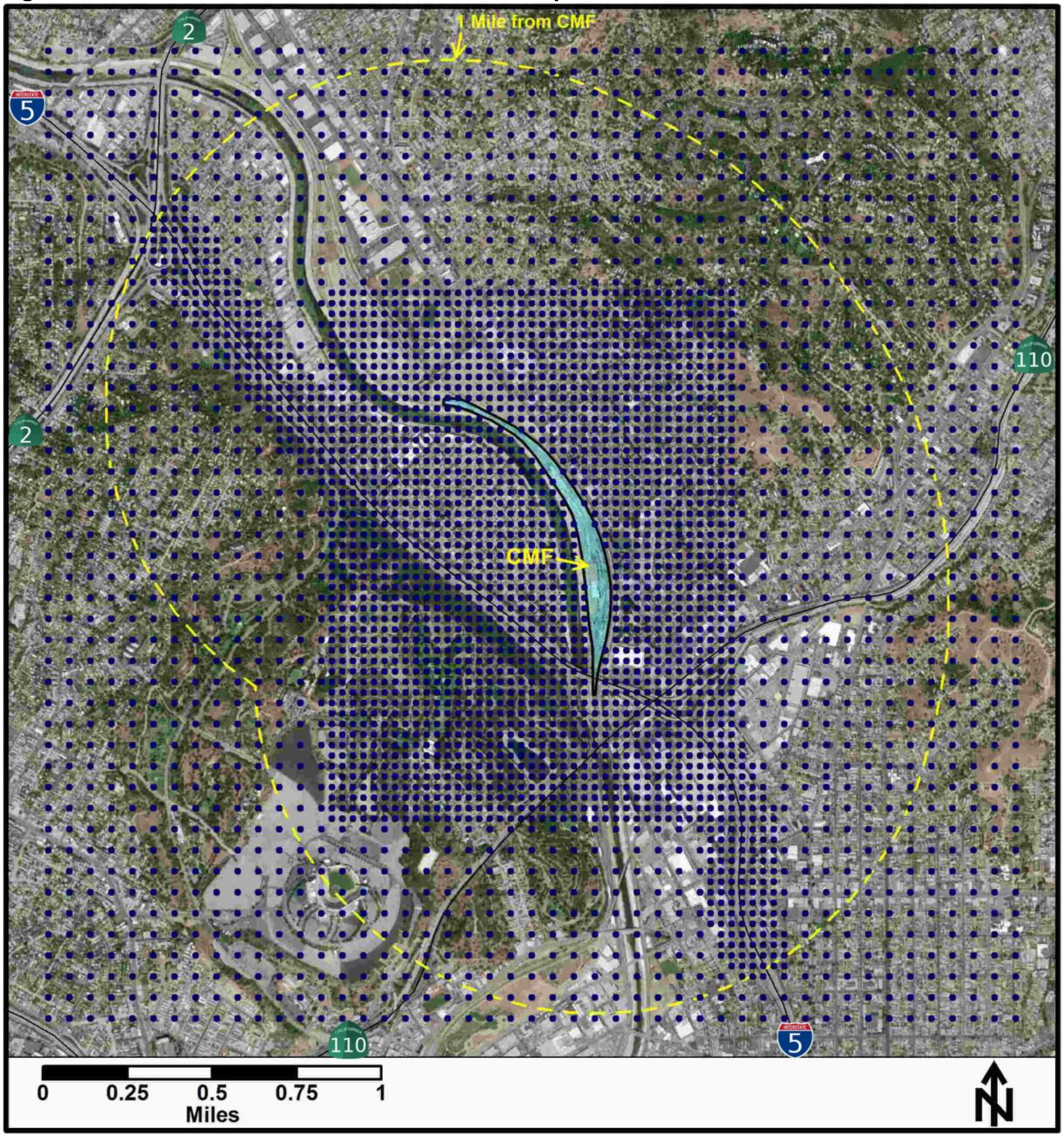
The fine receptor grid consists of 2,207 receptor points, positioned at 50-meter intervals, arranged in a grid measuring 1.9 kilometers (km) by 2.5 km (approximately 1.2 miles by 1.6 miles), and extending farther along the I-5 corridor. The purpose of the fine receptor grid is to identify maximum individual health risks to the nearest 50 meters and provide excellent resolution for the creation of health risk contours (isopleths) in close proximity to the CMF and off-site sources. For the purposes of identifying the maximum individual health risks, the fine grid receptors were classified as residential, worker, or unoccupied based on the land use at each of their locations.

The medium receptor grid consists of 1,685 receptor points, positioned at 100-meter intervals, arranged in a grid measuring 4.6 km by 4.6 km (approximately 3 miles by 3 miles). The purpose of the medium receptor grid is to provide sufficient resolution for the creation of health risk isopleths within one mile of the CMF. The fine and medium receptor grids are shown in Figure 4-2.

The coarse receptor grid consists of 1,600 receptor points, positioned at 500-meter intervals, arranged in a grid measuring 20 km by 20 km (approximately 12 miles by 12 miles). The purpose of the coarse receptor grid is to provide sufficient resolution for the creation of health risk isopleths over a large region centered over the CMF. The coarse receptor grid is shown in Figure 4-3.

Sensitive receptors were modeled in the actual locations of child care centers, medical facilities, schools, and convalescent homes within one mile of the CMF. The purpose of the sensitive receptors is to determine the health risks for individuals who are considered by OEHHA guidelines (OEHHA, 2003) to be more sensitive to air pollution, such as children, the elderly, and the infirm. Sensitive receptors were identified for this study through a search of publicly available databases, including the Los Angeles Times California Schools Guide (schools.latimes.com), Yellow Pages (www.yellowpages.com), Los Angeles County Department of Public Social Services (www.ladpss.org/dpss/childcare/search.cfm), and Google Maps (www.google.com/maps). The search resulted in the identification of 35 sensitive receptors

Figure 4-2. Modeled Fine and Medium Grid Receptor Locations



within one mile of the CMF, including 12 child care facilities, four medical facilities, and 19 schools. No convalescent homes were identified within one mile of the CMF. In response to public requests, Metrolink also included L.A. River users and L.A. River bike path users as sensitive recreational receptors. L.A. River users were modeled as 33 receptor points positioned every 50 meters along the river centerline, and L.A. River bike path users were modeled as 28 receptor points positioned every 50 meters along the bike path. For reporting purposes, the receptor with the highest diesel PM concentration and health risk values was selected and reported. Table 4-1 provides a list of modeled sensitive receptors, and Figure 4-4 shows their locations.

Census block centroids are receptor points located at the approximate center of each U.S. census block. This study modeled all census block centroids within an area 2.7 km by 2.9 km (1.7 miles by 1.8 miles), roughly centered over the CMF. The purpose of the census block centroid receptors is to estimate the number of residents exposed to various levels of health risk from the

Figure 4-3. Modeled Coarse Grid Receptor Locations

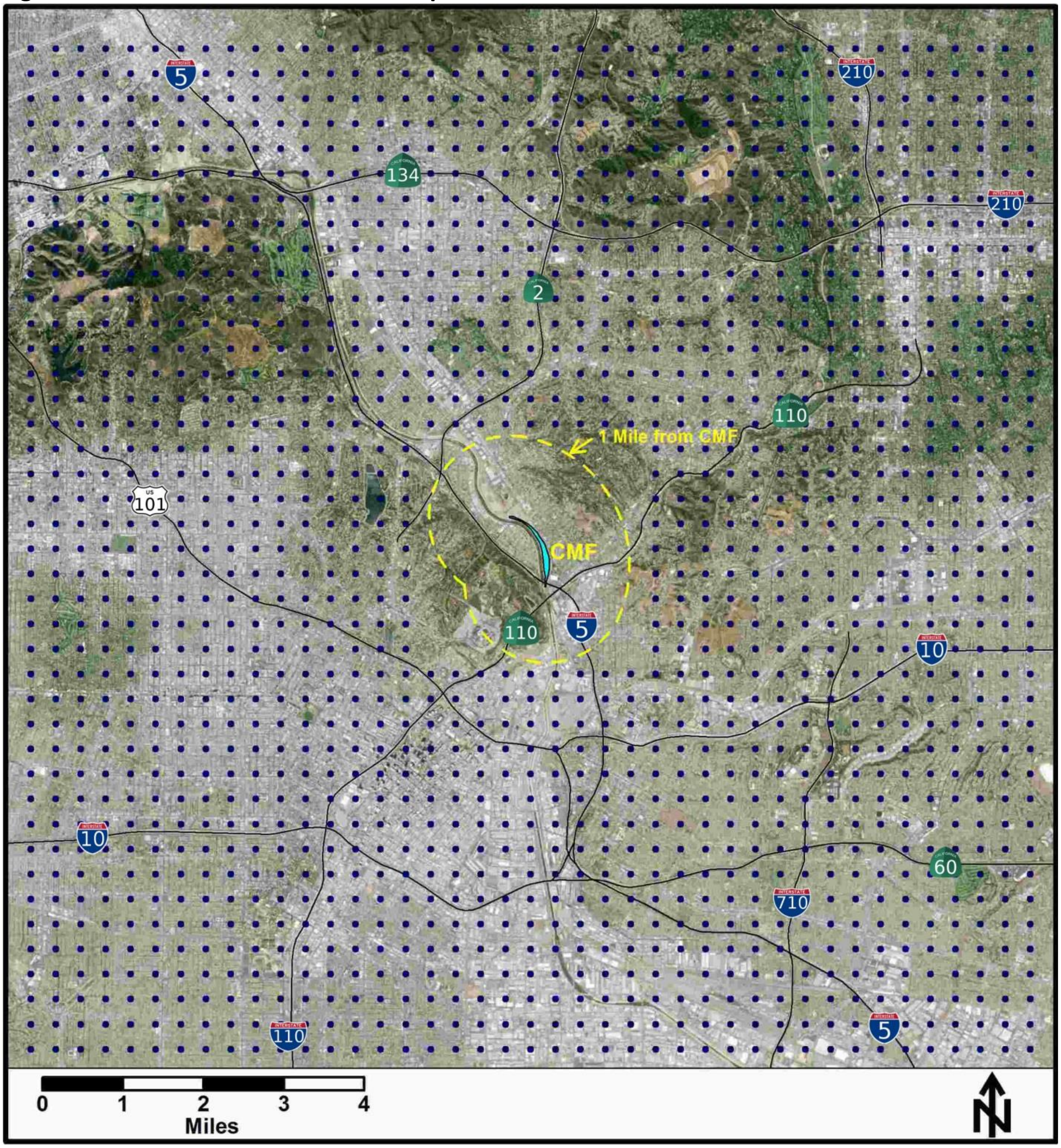


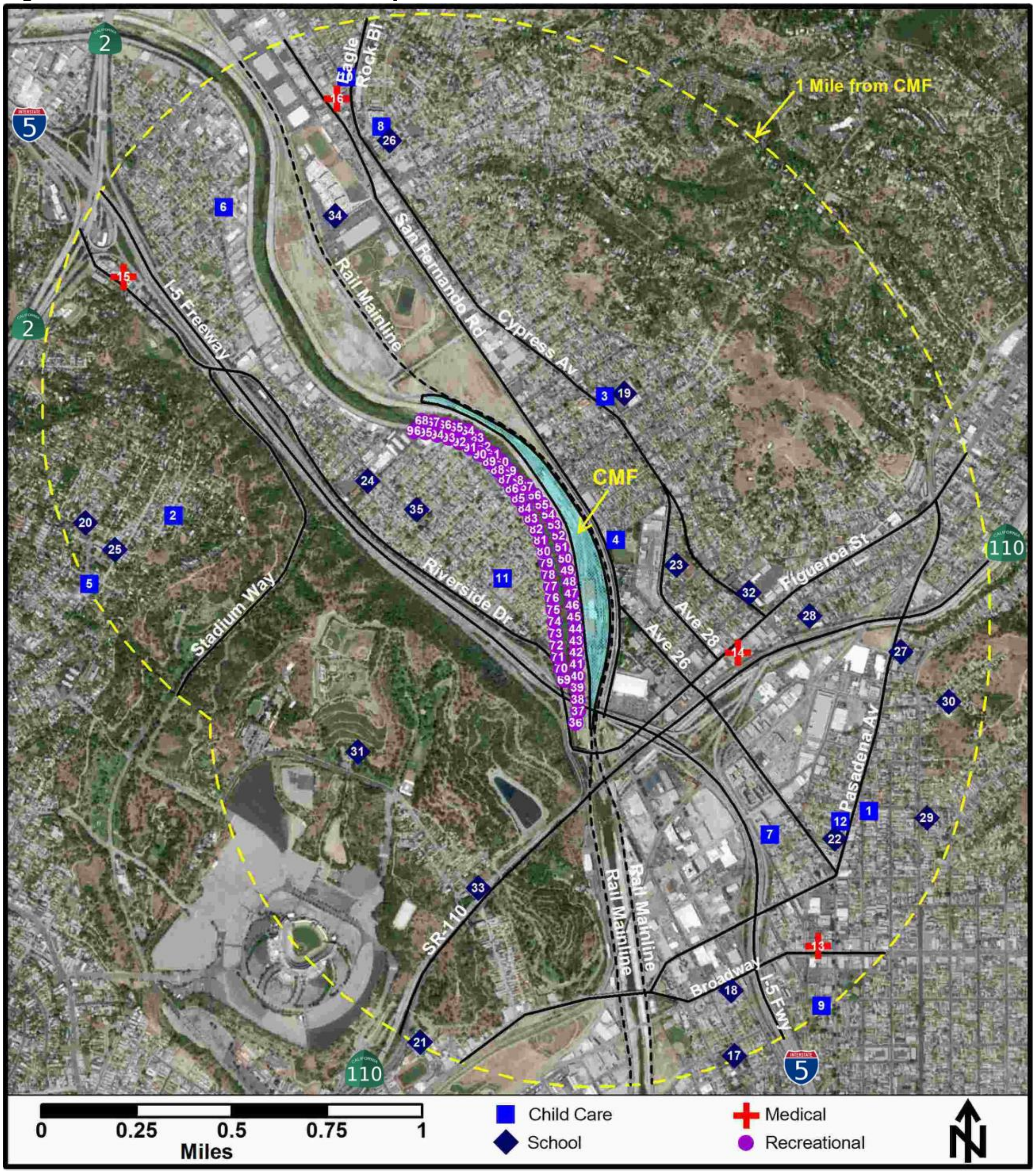
Table 4-1. Modeled Sensitive Receptor Descriptions within One Mile of the CMF

ID	Description	Street Address	City	Zip
Child Care Receptors				
1	Avenue 28 Head Start/State Preschool	220 E Ave 28	L.A.	90031
2	Cottage Enrichment	2208 Avon Street	L.A.	90026
3	Cypress I Preschool	1145 Cypress Ave	L.A.	90065
4	Cypress Park Head Start	2630 Pepper Ave	L.A.	90065
5	Echo Park Head Start	1962 Echo Park Ave	L.A.	90026
6	Escobar Family Child Daycare Provider	2008 Blake Ave	L.A.	90039
7	Flores De Valle	225 N Avenue 25	L.A.	90031
8	Glassell Park Early Education Center	3003 N Carlyle Street	L.A.	90065
9	Jardin De Ninos Child Care Center	2422 Manitou Ave	L.A.	90031
10	Kedron Head Start & Preschool	2415 W Avenue 30	L.A.	90065
11	Learning Bear Child Care and Preschool	2318 Fernleaf St	L.A.	90031
12	Placita De Ninos Inc	2261 Pasadena Ave	L.A.	90031
Medical Facilities				
13	Arroyo Vista Family Health Center	2411 N Broadway	L.A.	90031
14	Health Care Services Lincoln Heights	2820 N Figueroa St	L.A.	90065
15	Los Angeles Sleep Institute	1989 Riverside Drive	L.A.	90039
16	Santa Maria Family Medical Clinic	2209 N San Fernando Rd	L.A.	90065
Schools				
17	Albion Elementary School	322 S Ave 18	L.A.	90031
18	Alliance Susan & Eric Smidt Technology High School; Alliance College-Ready Middle Academy	211 S Ave 20	L.A.	90031
19	Aragon Avenue Elementary School	1118 Aragon Ave	L.A.	90065
20	Baxter Montessori School	2101 Echo Park Ave	L.A.	90026
21	Cathedral High School	1253 Bishops Rd	L.A.	90012
22	College Ready Middle Academy No. 7	2635 Pasadena Ave	L.A.	90031
23	Divine Saviour School	624 Cypress Ave	L.A.	90065
24	Dorris Place Elementary School	2225 Dorris Pl	L.A.	90031
25	Elysian Heights Elementary School	1562 Baxter Street	L.A.	90026
26	Glassell Park Elementary School	2211 W Avenue 30	L.A.	90065
27	Hillside Elementary School	120 East Avenue 35	L.A.	90031
28	Loreto Street Elementary School	3408 Arroyo Seco Ave	L.A.	90065
29	Los Angeles Leadership Academy	2670 Griffin Ave	L.A.	90031
30	Los Angeles Leadership Academy; Crittenton High School	234 E Avenue 33	L.A.	90031
31	Los Angeles Theatre Academy	929 Academy Rd	L.A.	90012
32	Nightingale Middle School	3311 N Figueroa St	L.A.	90065
33	Solano Avenue Elementary School	615 Solano Ave	L.A.	90012
34	Sonia Sotomayor Learning Academies; Los Angeles River School; Alliance Tennenbaum Family Technology High School	2050 N San Fernando Rd	L.A.	90065
35	St Ann Religious Education	2302 Riverdale Ave	L.A.	90031
Recreational Uses				
36-68	LA River User	--	L.A.	--
69-96	LA River Bike Path	--	L.A.	--

Notes:

1. See Figure 4-4 for a map of the sensitive receptor locations.

Figure 4-4. Modeled Sensitive Receptor Locations within One Mile of the CMF



Notes:

1. See Table 4-1 for a list of sensitive receptors by the ID numbers in this figure.

CMF and off-site sources. The census block centroid locations and representative populations were obtained directly from the Hotspots Analysis Reporting Program (HARP) risk assessment model (CARB, 2013b). Because the HARP census block data are based on the U.S. Census Bureau's 2000 Census, the census block populations were scaled up for each analysis year assuming a 10-year growth rate of 3.1 percent for Los Angeles County (U.S. Census Bureau, 2011).

All modeled receptors were assigned their actual elevations in AERMOD. Elevations were derived from U.S. Geological Survey National Elevation Dataset (NED) 1/3-arcsecond files (U.S. Geological Survey, 2014). To avoid potentially underestimating diesel PM concentrations at L.A. River receptors, those receptors were modeled twice, once with their actual elevations and once with their elevations manually adjusted to match the CMF site elevation. The highest result was used in the health risk calculations. This approach is recommended by the SCAQMD (2013) when modeling receptors at elevations lower than the source elevations.

5. Health Risk Assessment

5.1 Risk Assessment Approach

The CMF and off-site sources HRA was prepared using current risk assessment guidelines published by the California Office of Environmental Health Hazard Assessment (OEHHA, 2003)[1] and rail yard-specific supplemental guidelines published by the California Air Resources Board (CARB, 2006). The CMF HRA is similar in approach to 17 other HRAs for major California rail yards prepared by CARB in 2007 pursuant to a 2005 agreement with the Class I railroads. The CARB rail yard HRAs represent the industry standard for rail yard HRAs in California. Using this same approach for the CMF HRA ensures a consistent, reliable, and previously validated methodology.

Health risk values were calculated using CARB's Hotspots Analysis Reporting Program (HARP) risk assessment model, version 1.4f (CARB, 2013b). HARP accepts the five-year average diesel PM concentrations predicted by AERMOD as inputs, applies the appropriate diesel PM toxicity factors and exposure assumptions, and produces estimates of human health risk at each modeled receptor as output. The toxicity values for diesel PM are established by CARB (2014b).

Exposures to pollutants originally emitted into the air can occur through various pathways as a result of breathing, dermal contact, ingestion of contaminated produce, and ingestion of fish that have taken up contaminants from water bodies. These exposures can all contribute to an individual's health risk. However, diesel PM risk is evaluated by the inhalation pathway only in this study because the risk contributions by other pathways of exposure are insignificant relative to the inhalation pathway (CARB, 2007).

Two health risk indicators were quantified by HARP in this study, cancer risk and chronic hazard index. These two indicators are described in the following sections.

5.1.1 Definition of Cancer Risk

Cancer risk is usually expressed as the number of chances or persons in a population of a million people that might contract cancer. For example, the number may be stated as "10 in a million" or "10 chances per million". If a population of one million people was exposed to the same potential cancer risk (e.g., 10 chances per million), then statistics would predict that no more than 10 of those million people exposed would be likely to develop cancer from exposure to toxic air contaminant emissions from a facility.

The methodology used to estimate the potential cancer risks is consistent with the Tier-1 analysis of Air Toxics Hot Spots Program Risk Assessment Guidelines (OEHHA, 2003). A "Tier-1"

[1] OEHHA is in the process of revising its risk assessment guidelines, and CARB is revising the HARP risk assessment model to use the revised guidelines. The revised guidelines will include updated exposure parameters (e.g., inhalation rate, food consumption rate, etc.) based on the most recent data, including exposure factors for infants and children, in accordance with the mandate of the Children's Environmental Health Protection Act (Senate Bill 25, Escutia, Chapter 731, Statutes of 1999, Health and Safety Code Sections 39669.5 et seq.). The revised guidelines will also update the approach to assessing dermal exposure. OEHHA and CARB anticipate that the revised guidelines and companion HARP model will be finalized and made publicly available sometime in 2015. Accordingly, the CMF and off-site sources HRA was prepared using the current 2003 guidelines.

analysis assumes conservative OEHHA-recommended assumptions, such as an individual resident is exposed to an annual average concentration of a given pollutant nearly continuously for 70 years. The length of time that an individual is exposed to a given air concentration is proportional to the risk. During childhood, the risk from exposure to a given air concentration is greater. According to OEHHA guidelines (OEHHA, 2003), exposure durations of 30 years (average residential exposure) or nine years (school-age child exposure) may also be evaluated as supplemental information to present the range of cancer risk based on residency period. Therefore, this HRA identifies maximum cancer risk results for the following exposure scenarios, described below and summarized in Table 5-1:

- **$MEIR_{70}$** - Maximally-exposed individual resident based on a 70-year lifetime exposure period; evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 liters per kilogram body weight per day (L/kg/day). The 80^{th} percentile breathing rate is recommended by CARB "where a single cancer risk value for a residential receptor is needed for risk management decisions" (CARB, 2003).

- **$MEIR_{30}$** - Maximally-exposed individual resident based on a 30-year exposure period; evaluated with an exposure of 24 hours per day, 350 days per year, for 30 years, and an 80th percentile breathing rate of 302 L/kg/day.

- **MEIW** - Maximally-exposed individual worker; evaluated with an exposure of eight hours per day, 245 days per year, for 40 years, and an occupational breathing rate of 447 L/kg/day (which equates to 149 L/kg per 8-hour day). In accordance with CARB guidelines, an adjustment factor of 2.2 was applied to worker risks to account for the alignment of a worker's schedule with the daily emissions profile at the CMF (CARB, 2006).

- **Sensitive** - Maximally-exposed sensitive receptor; evaluated using the following assumptions:

  - Child care receptors were evaluated with an exposure of 24 hours per day, 350 days per year, for nine years, and an elevated (child) breathing rate of 581 L/kg/day. The HRA identified and evaluated 12 child care facilities within one mile of the CMF.

  - Medical receptors were evaluated with an exposure of 24 hours per day, 350 days per year, for 30 years, and an 80th percentile breathing rate of 302 L/kg/day. The HRA identified and evaluated four medical facilities within one mile of the CMF.

  - School receptors were evaluated with an exposure of 24 hours per day, 350 days per year, for nine years, and an elevated (child) breathing rate of 581 L/kg/day. The HRA identified and evaluated 19 schools within one mile of the CMF.

  - Recreational receptors were evaluated with an exposure of two hours per day, 245 days per year, for 40 years, and an elevated (exercise) breathing rate of 1,097 L/kg/day (which equates to 91 L/kg per two-hour day). Based upon feedback and input from community stakeholders, the HRA evaluated two recreational receptors: L.A. River users (such as kayakers) and L.A. River bike path users.

- **MICR** - Maximum individual cancer risk; this is simply the maximum cancer risk of the $MEIR_{70}$, $MEIR_{30}$, MEIW, and Sensitive categories.

- **PMI** - Point of maximum impact; this is the maximum potential cancer risk at any location regardless of whether the location is occupied; evaluated with the $MEIR_{70}$ exposure assumptions of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day.

The cancer risks presented for each analysis year (whether 2010, 2012, 2014, or 2017) conservatively assume that year's diesel PM emissions remain constant for the entire exposure period, which is up to 70 years depending on the exposure scenario. This assumption is conservative because emissions are on a declining trend from 2010 to 2017 (as demonstrated by Figure 3-1), and will likely continue to decline beyond 2017 as vehicles and equipment reach the end of their useful life and are replaced by newer, less emissive equipment.

Table 5-1. Exposure Scenarios Evaluated for Cancer Risk

Receptor Type	Receptor Category	Exposure Frequency (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Breathing Rate (L/kg/day) [1]
$MEIR_{70}$	Residential	24	350	70	302
$MEIR_{30}$	Residential	24	350	30	302
MEIW	Occupational	8	245	40	447 [3]
Sensitive	Child Care	24	350	9	581
	Medical	24	350	30	302
	School	24	350	9	581
	Recreational	2	245	40	1,097 [4]
MICR	MICR is the maximum cancer risk of MEIR70, MEIR30, MEIW, and Sensitive				
PMI	-- [2]	24	350	70	302

Notes:

1. L/kg/day is liters of air per kilogram body weight per 24-hour day.
2. PMI is the maximum potential cancer risk at any location regardless of whether the location is occupied.
3. This equates to 149 L/kg per 8-hour day.
4. This equates to 91 L/kg per 2-hour day.
5. Source: CARB, 2006; OEHHA, 2003.

5.1.2 Definition of Chronic Hazard Index

A reference exposure level (REL) is used to predict if there may be an increased risk of certain types of adverse non-cancer health conditions after chronic (long-term) exposure to toxic air contaminants. CARB lists the respiratory system as the toxic endpoint most likely affected by chronic exposure to diesel PM (CARB, 2014b). To calculate the chronic hazard index, the concentration to which a person is exposed is divided by the REL. Typically, the greater the hazard index is above 1, the greater the risk of possible adverse health effects. If the hazard index is less than 1, adverse effects are less likely to happen (OEHHA, 2003). In accordance with CARB and OEHHA guidelines (CARB, 2006; OEHHA, 2003), the CMF and off-site sources HRA identified maximum chronic hazard indices for the following exposure scenarios:

- **MEIR** - Maximally-exposed individual resident; assumes continuous long-term exposure to average diesel PM concentration.

- **MEIW** - Maximally-exposed individual worker; assumes continuous long-term exposure to average diesel PM concentration.

- **Sensitive** - Maximally-exposed sensitive receptor; assumes continuous long-term exposure to average diesel PM concentration.

- **PMI** – Point of maximum impact; this is the maximum potential chronic hazard index at any location regardless of whether the location is occupied.

5.1.3 Other Potential Health Risk Indicators

From a risk management perspective, CARB staff believes it is reasonable to focus an HRA on diesel PM cancer risk because it is the predominant risk driver, and the most effective parameter to evaluate risk reduction actions (CARB 2007). Therefore, the primary health risk indicator quantified in this HRA is cancer risk associated with diesel PM emissions. Some of the less common health risk indicators, which are not quantified in this study, are briefly discussed below. It is expected that the steeply declining trend in diesel PM emissions, cancer risks, and chronic non-cancer hazard indices demonstrated in this HRA would also be seen in these indicators.

For premature deaths linked to diesel PM emissions in the South Coast Air Basin, ARB staff estimated about 2,000 premature deaths per year due to diesel exhaust exposure in 2005 (CARB, 2008). The total diesel PM emissions from all sources in the South Coast Air Basin were estimated at 7,746 tons for the year 2005 (ARB, 2006c). The CMF diesel PM emissions, on the other hand, are estimated to range from 3.6 tons in 2010 to 0.76 tons in 2017, less than 0.05 percent of the total 2005 air basin diesel PM emissions. For comparison with another major source of diesel PM emissions in South Coast Air Basin, the diesel PM emissions from the Ports of Los Angeles and Long Beach combined were estimated at 1,760 tons per year in 2002 (CARB, 2006d), resulting in an estimated 120 premature deaths per year (CARB, 2008). The CMF diesel PM emissions, on the other hand, are estimated to be less than or equal to 0.2 percent of the total 2002 port-wide diesel PM emissions.

Due to the uncertainties in the toxicological and epidemiological studies, diesel PM as a whole was not assigned a short-term acute non-cancer REL for the purposes of estimating short-term health effects. Only the specific compounds of diesel exhaust (e.g., acrolein) that independently have potential acute effects (such as irritation of the eyes and respiratory tract) have assigned acute RELs. However, acrolein is a chemically reactive and unstable compound, and easily reacts with a variety of chemical compounds in the atmosphere. Compared to the other compounds in diesel exhaust, the concentration of acrolein has a much lower chance of reaching a distant off-site receptor. More importantly, given the multitude of activities ongoing at facilities as complex as rail yards, there is a much higher level of uncertainty associated with maximum hourly-specific emission data, which are essential for assessing acute risk (CARB, 2007). Therefore, similar to the CARB rail yard HRAs, non-cancer acute risk is not addressed quantitatively in this study.

5.2 Risk Characterization Associated with the CMF

5.2.1 Cancer Risk Associated with the CMF

Table 5-2 presents the maximum estimated cancer risks associated with CMF diesel PM emissions. The values in Table 5-2 represent the highest risks at any modeled receptor for each displayed receptor category. The risks at all other modeled locations are less than the values in the table. Results are presented for each of the four analysis years included in the emissions assessment. The table shows that the risks will decline substantially from 2010 to 2017 for all receptor categories.

In 2010, prior to implementation of emission reduction measures, the risk for the maximally-exposed individual resident ($MEIR_{70}$) was estimated to be 243 in a million, based on 70-year residential exposure assumptions. In 2012, after implementation of the fuel conservation program and modified yard operations, the $MEIR_{70}$ was estimated to be 113 in a million, a reduction of 54 percent from 2010. In 2014, after a reduction in the number of trains, an expanded ground power program, and introduction of the electric railcar mover, the $MEIR_{70}$ is estimated to be 84 in a million, a reduction of 65 percent from 2010. In 2017, after introduction of 20 Tier 4 locomotives to the Metrolink fleet, the $MEIR_{70}$ is estimated to be 40 in a million, a reduction of 83 percent from 2010. To provide context, Section 5.5 provides information on the overall background cancer risk that exists throughout the South Coast Air Basin from all sources of toxic air contaminants.

For each analysis year, the cancer risks for a maximally-exposed 30-year resident ($MEIR_{30}$), worker (MEIW), and sensitive receptor are all estimated to be less than the $MEIR_{70}$ risk. Therefore, the maximum individual cancer risk (MICR) is equal to the $MEIR_{70}$ risk for each analysis year. The point of maximum impact (PMI) ranges from 670 in a million in 2010 to 130 in a million in 2017. However, the PMI occurs on unoccupied land near the CMF boundary, which means no person is exposed to this level of risk.

Figures 5-1 through 5-4 show contour lines, or "isopleths", of CMF cancer risk per million for analysis years 2010 through 2017. The isopleths reflect 70-year residential exposure assumptions (i.e., the same assumptions used to evaluate $MEIR_{70}$). The isopleths can be used to estimate the individual cancer risk at any location in the vicinity of the CMF. For example, an individual living on the "10" isopleth would have a cancer risk of 10 in a million if exposed nearly continuously for 70 years. The contraction of the isopleths from 2010 to 2017 is indicative of the substantial risk reductions predicted for the CMF.

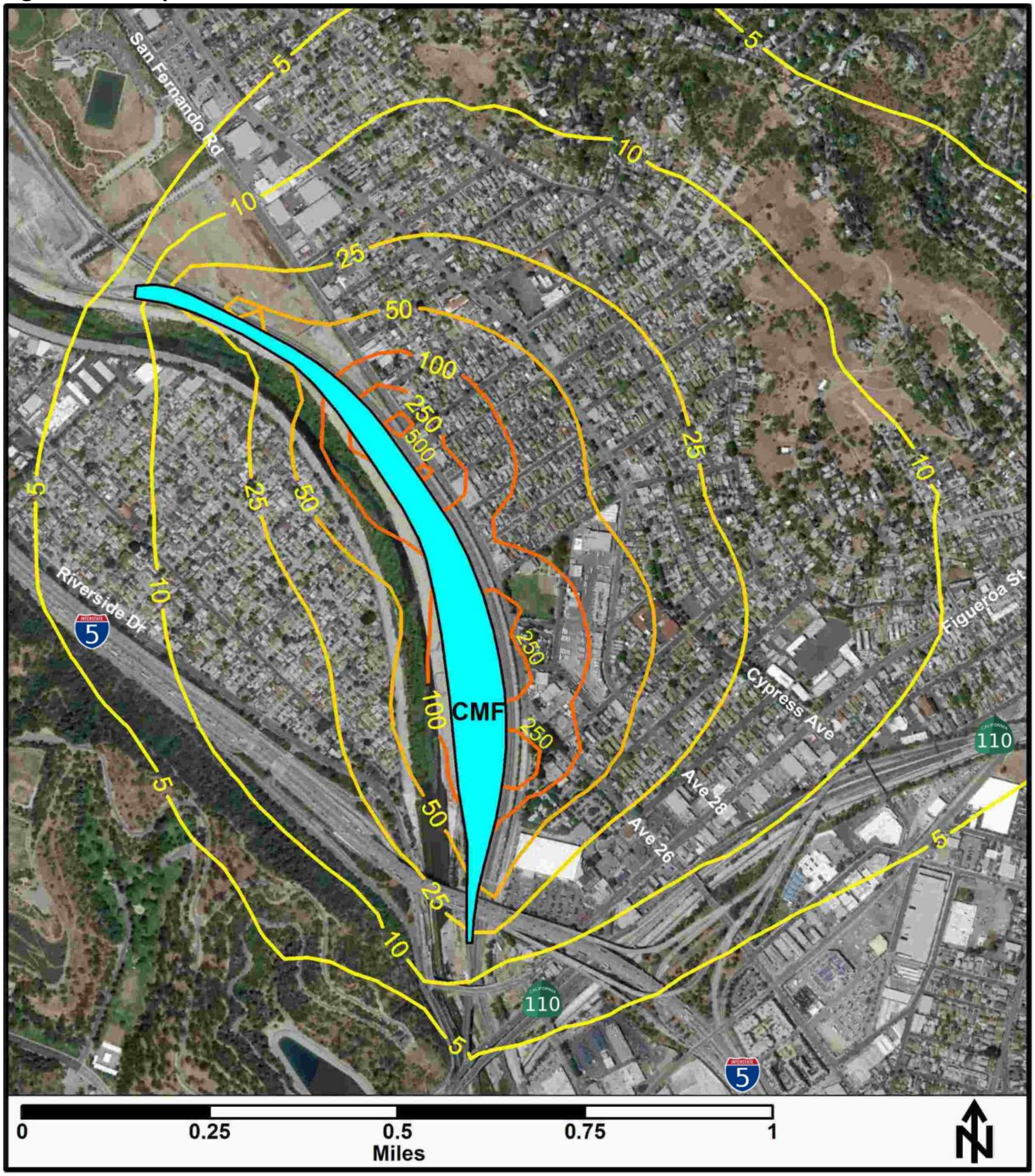
Table 5-2. Maximum Estimated Cancer Risks Associated with the CMF

Receptor	Maximum Estimated Cancer Risk [1] (chances per million people)			
	2010	2012	2014	2017
$MEIR_{70}$	243	113	84	40
$MEIR_{30}$	104	48	36	17
MEIW	162	79	64	30
Sensitive	39	23	18	9
MICR	243	113	84	40
PMI	670	338	281	130
Change in $MEIR_{70}$ Relative to 2010	**--**	**-54%**	**-65%**	**-83%**

Notes:

1. The values reported in the table represent the locations with the highest estimated risk, which are near the CMF boundary. See Figures 5-1 through 5-4 for maps of cancer risk in all locations surrounding the CMF.
2. $MEIR_{70}$ - Maximally-exposed individual resident (70-year exposure); evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day.
3. $MEIR_{30}$ - Maximally-exposed individual resident (30-year exposure); evaluated with an exposure of 24 hours per day, 350 days per year, for 30 years, and an 80th percentile breathing rate of 302 L/kg/day.
4. MEIW - Maximally-exposed individual worker; evaluated with an exposure of 8 hours per day, 245 days per year, for 40 years, and an occupational breathing rate of 447 L/kg/day (which equates to 149 L/kg per 8-hour day).
5. Sensitive - Maximally-exposed sensitive receptor.
6. MICR - Maximum individual cancer risk (the maximum of MEIR70, MEIR30, MEIW, and Sensitive).
7. PMI - Point of maximum impact (unoccupied land near CMF boundary); evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day.
8. The cancer risks presented for each analysis year assume that year's diesel PM emissions remain constant for the entire exposure period.

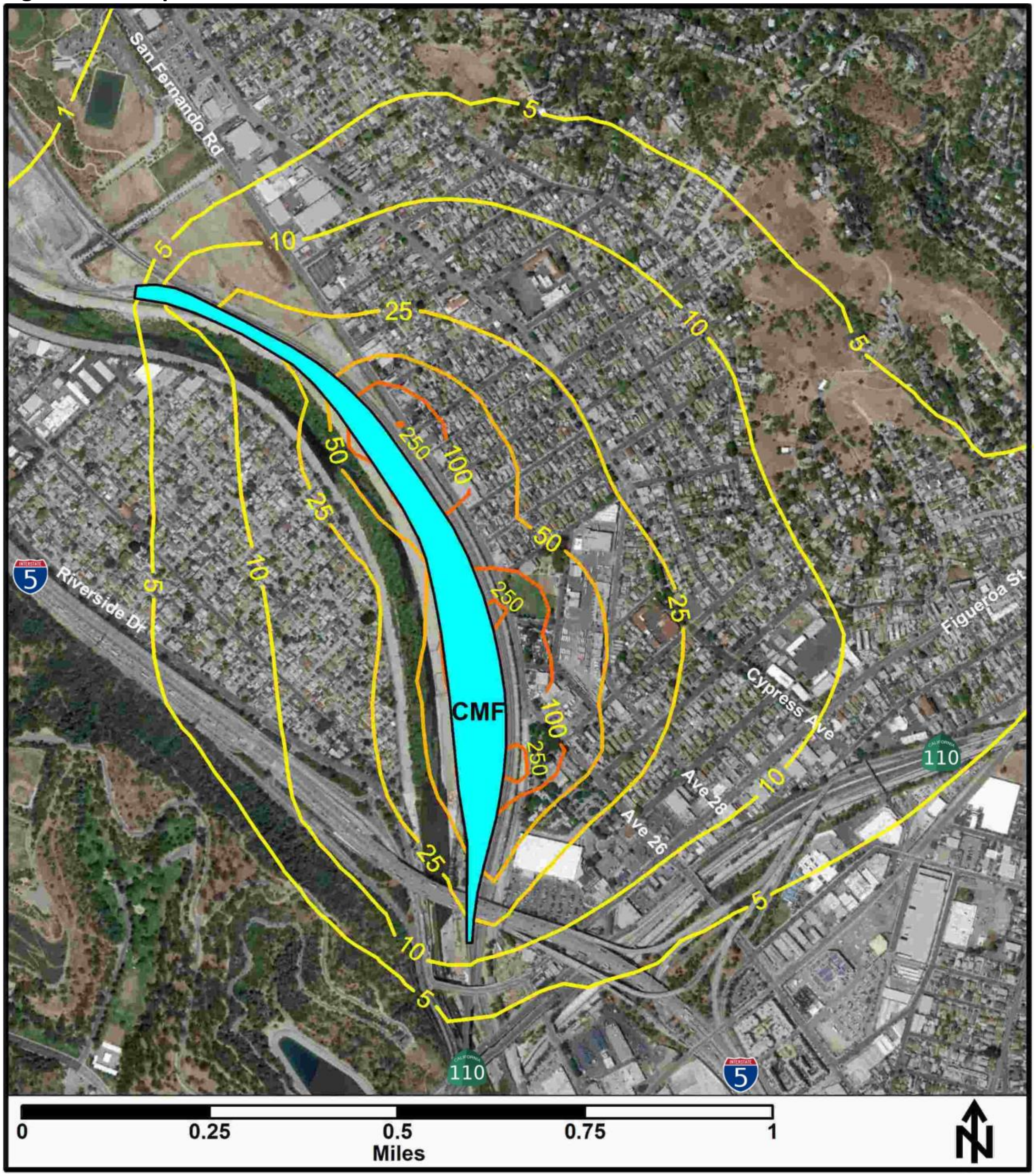
Figure 5-1. Isopleths of Individual Cancer Risk from the CMF – Year 2010



Notes:

1. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine MEIR70).
2. Cancer risks assume the CMF on-site diesel PM emissions remain constant at 2010 levels for all 70 years of exposure.

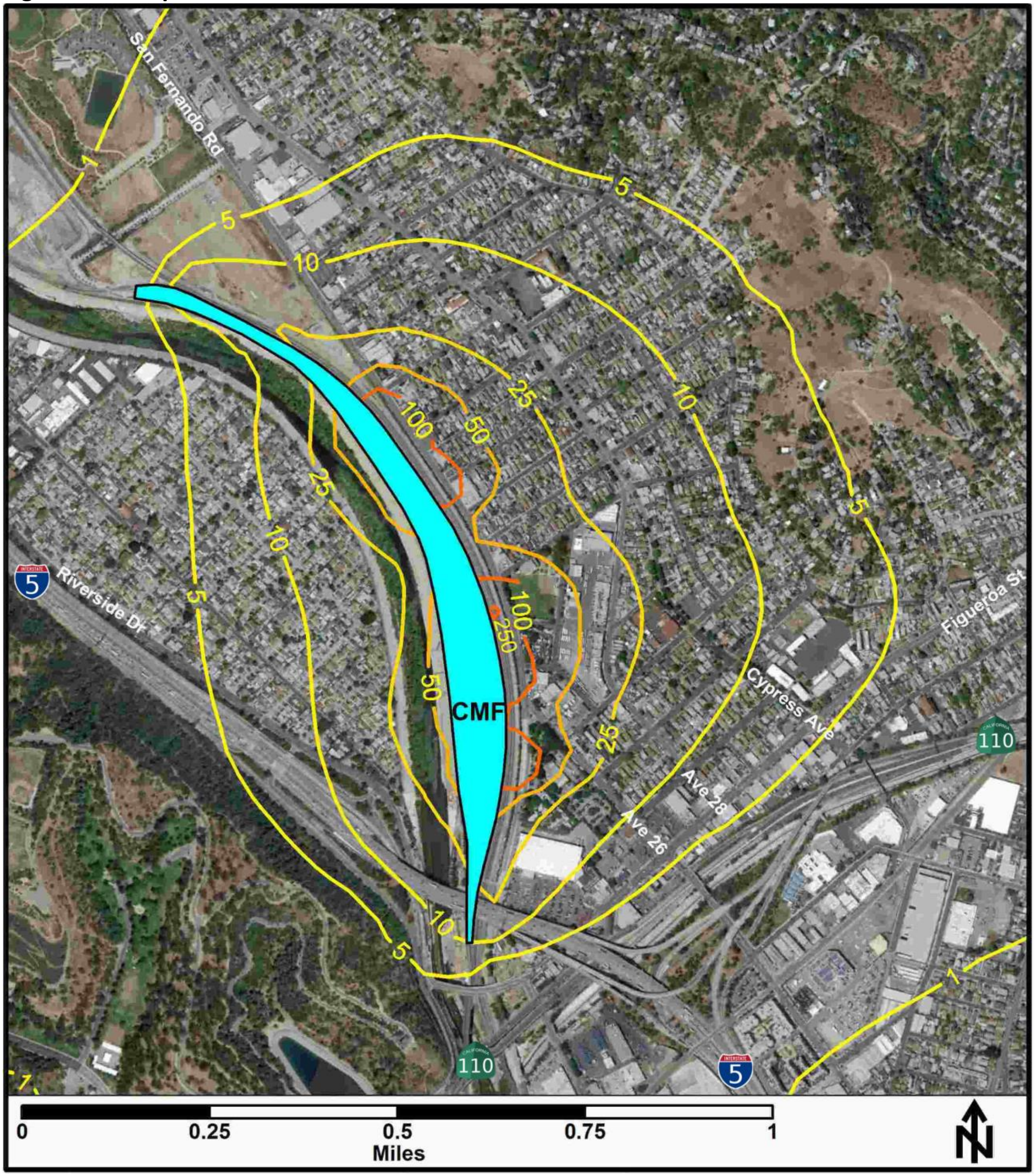
Figure 5-2. Isopleths of Individual Cancer Risk from the CMF – Year 2012



Notes:

1. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine MEIR70).
2. Cancer risks assume the CMF on-site diesel PM emissions remain constant at 2012 levels for all 70 years of exposure.

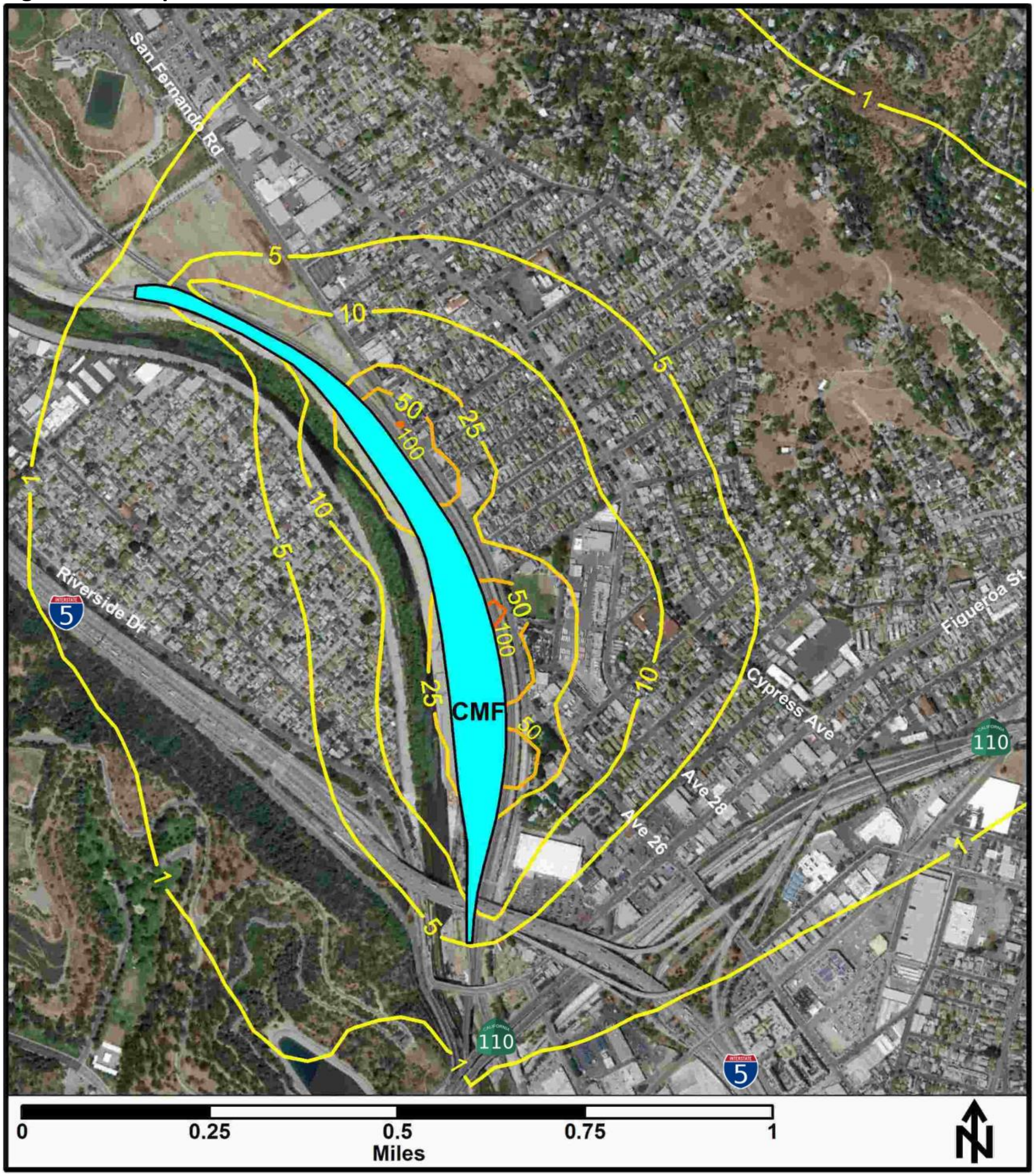
Figure 5-3. Isopleths of Individual Cancer Risk from the CMF – Year 2014



Notes:

1. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine MEIR70).
2. Cancer risks assume the CMF on-site diesel PM emissions remain constant at 2014 levels for all 70 years of exposure.

Figure 5-4. Isopleths of Individual Cancer Risk from the CMF – Year 2017



Notes:

1. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine MEIR70).
2. Cancer risks assume the CMF on-site diesel PM emissions remain constant at 2017 levels for all 70 years of exposure.

5.2.2 Chronic Hazard Indices Associated with the CMF

Table 5-3 presents the maximum estimated chronic hazard indices associated with CMF diesel PM emissions. The table shows that the hazard indices are less than 1.0 at all modeled receptors in all analysis years. According to OEHHA guidelines (OEHHA, 2003), these levels indicate that the CMF is not expected to cause a substantial non-cancer health risk to the public from diesel PM above the background risk level that already exists throughout the South Coast Air Basin. The chronic hazard indices show a similar declining trend as the cancer risk values, achieving a reduction of 83 percent by 2017 compared to 2010.

Table 5-3. Maximum Estimated Chronic Hazard Indices Associated with the CMF

Receptor	Maximum Estimated Chronic Hazard Index [1]			
	2010	2012	2014	2017
MEIR	0.15	0.07	0.05	0.03
MEIW	0.23	0.11	0.09	0.04
Sensitive	0.09	0.06	0.05	0.02
PMI	0.42	0.21	0.18	0.08
Change in MEIR Relative to 2010	--	**-54%**	**-65%**	**-83%**

Notes:

1. The values reported in the table represent the locations with the highest estimated hazard indices, which are near the CMF boundary.
2. MEIR - Maximally-exposed individual resident.
3. MEIW - Maximally-exposed individual worker.
4. Sensitive - Maximally-exposed sensitive receptor.
5. PMI - Point of maximum impact (unoccupied land near CMF boundary).

5.2.3 Impacted Areas and Population Associated with the CMF

Table 5-4 presents the estimated number of acres and residents exposed to various ranges of cancer risks associated with CMF diesel PM emissions. The cancer risks used to determine the quantities in the table reflect 70-year residential exposure assumptions (i.e., the same assumptions used to evaluate $MEIR_{70}$). The population-based analysis was conducted by modeling census block centroids (the population-weighted centers of census blocks) in AERMOD and HARP. The entire population of each census block was assumed to be exposed to the cancer risk at the centroid. HARP contains census data from the U.S. Census Bureau's 2000 Census (CARB, 2013b). For each analysis year, the population was scaled up from the 2000 Census data assuming a 10-year growth rate of 3.1 percent for Los Angeles County (U.S. Census Bureau, 2011).

Table 5-4 shows that, from 2010 to 2017, both the geographical area and number of persons exposed to each range of cancer risk will decrease substantially. For example, the geographical area exposed to a 70-year residential cancer risk greater than or equal to 10 in a million will decrease from 574 acres in 2010 to 160 acres in 2017 (including the acreage of the CMF itself), a decrease of 72 percent. Similarly, the number of persons exposed to a 70-year residential cancer risk greater than or equal to 10 in a million will decrease from 11,453 persons in 2010 to 2,775 persons in 2017, a decrease of 76 percent.

Table 5-4. Estimated Impacted Areas and Population Exposed to Various Cancer Risk Levels from the CMF

Cancer Risk Range (per million)	Estimated Impacted Area (acres)				Estimated Exposed Population (persons)			
	2010	2012	2014	2017	2010	2012	2014	2017
10-25	295	215	168	99	6,193	5,566	4,261	2,707
26-50	130	90	64	39	2,607	2,573	1,744	68
51-100	75	49	38	21	1,763	77	68	0
101-250	53	36	23	0	890	67	0	0
> 250	21	2	0	0	0	0	0	0
Total ≥ 10	**574**	**391**	**293**	**160**	**11,453**	**8,283**	**6,073**	**2,775**
Change Relative to 2010	**--**	**-32%**	**-49%**	**-72%**	**--**	**-28%**	**-47%**	**-76%**

Notes:

1. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine MEIR70).
2. The cancer risks for each analysis year assume that year's diesel PM emissions from the CMF remain constant for the entire exposure period.
3. The cancer risk ranges displayed in the table were selected for the purposes of comparison and discussion. The 10-per-million level was selected as the lowest range of cancer risk in the table because this level of risk is predicted to occur roughly on a local community scale.

5.2.4 Impacted Sensitive Receptors Associated with the CMF

Table 5-5 presents the number of modeled sensitive receptors exposed to various ranges of cancer risks associated with CMF diesel PM emissions. Each of the 37 sensitive receptors was modeled with the exposure assumptions appropriate for its receptor classification (child care, medical, school, or recreational), as described above in Section 5.1.1. Table 5-5 shows that, in 2010, 33 sensitive receptors were exposed to a cancer risk less than or equal to 10 in a million, two were exposed to a cancer risk between 11 and 25 in a million, and two were exposed to a cancer risk between 26 and 50 in a million. By 2017, all modeled sensitive receptors will be exposed to a cancer risk less than 10 in a million. The estimated cancer risk at each modeled sensitive receptor is provided in Appendix E. To provide context, Section 5.5 provides information on the overall background cancer risk that exists throughout the South Coast Air Basin from all sources of toxic air contaminants.

Table 5-5. Estimated Number of Sensitive Receptors Exposed to Various Cancer Risk Levels from the CMF

Cancer Risk Range (per million)	No. of Sensitive Receptors			
	2010	2012	2014	2017
0-10	33	35	35	37
11-25	2	2	2	0
26-50	2	0	0	0
51-100	0	0	0	0
101-250	0	0	0	0
> 250	0	0	0	0

Notes:

1. The cancer risks for each analysis year assume that year's diesel PM emissions from the CMF remain constant for the entire exposure period.
2. Modeled sensitive receptors are within one mile of the CMF.
3. The cancer risk ranges displayed in the table were selected for the purposes of comparison and discussion.

5.3 Risk Characterization Associated with Off-Site Emissions

5.3.1 Cancer Risk Associated with Off-Site Sources

Table 5-6 presents the maximum estimated cancer risks associated with off-site source diesel PM emissions that occur within one mile of the CMF. The values in Table 5-6 represent the highest risks at any modeled receptor for each displayed receptor category. The risks at all other modeled locations are less than the values in the table. Results are presented for each of the four analysis years included in the emissions assessment. The table shows that the risks will decline substantially from 2010 to 2017 for all receptor categories.

The decline in off-site source cancer risks is primarily due to the *Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants from In-Use On-Road Diesel-Fueled Vehicles* (CARB, 2010), which requires the phase-in of diesel particulate filters and stricter engine emission standards on heavy duty diesel trucks from 2012 to 2023. Normal fleet turnover, whereby older trucks and line haul locomotives reach the end of their useful lives and are replaced with newer, cleaner vehicles, also contributes to the decline in risks. Diesel truck traffic on I-5 accounts for 96 to 98 percent of the cancer risk at the MEIR receptors, depending on the analysis year.

In 2010, the risk for the maximally-exposed individual resident ($MEIR_{70}$) was estimated to be 401 in a million, based on 70-year residential exposure assumptions. In 2012, the $MEIR_{70}$ was estimated to be 346 in a million, a reduction of 14 percent from 2010. In 2014, the $MEIR_{70}$ is estimated to be 160 in a million, a reduction of 60 percent from 2010. In 2017, the $MEIR_{70}$ is estimated to be 103 in a million, a reduction of 74 percent from 2010.

For each analysis year, the cancer risks for a maximally-exposed 30-year resident ($MEIR_{30}$), worker (MEIW), and sensitive receptor are all estimated to be less than the $MEIR_{70}$ risk. Therefore, the maximum individual cancer risk (MICR) is equal to the $MEIR_{70}$ risk for each analysis year. The point of maximum impact (PMI) ranges from 639 in a million in 2010 to 163 in a million in 2017. However, the PMI occurs on unoccupied land near I-5, which means no person is exposed to this level of risk.

Figures 5-5 through 5-8 show isopleths of off-site source cancer risk per million for analysis years 2010 through 2017. The isopleths reflect 70-year residential exposure assumptions (i.e., the same assumptions used to evaluate $MEIR_{70}$). Although the off-site source emissions are limited to within one mile of the CMF, the cancer risk impacts extend beyond one mile, as illustrated in the figures and reflected in the areas and populations in Sections 5.3.3 and 5.3.4, below.

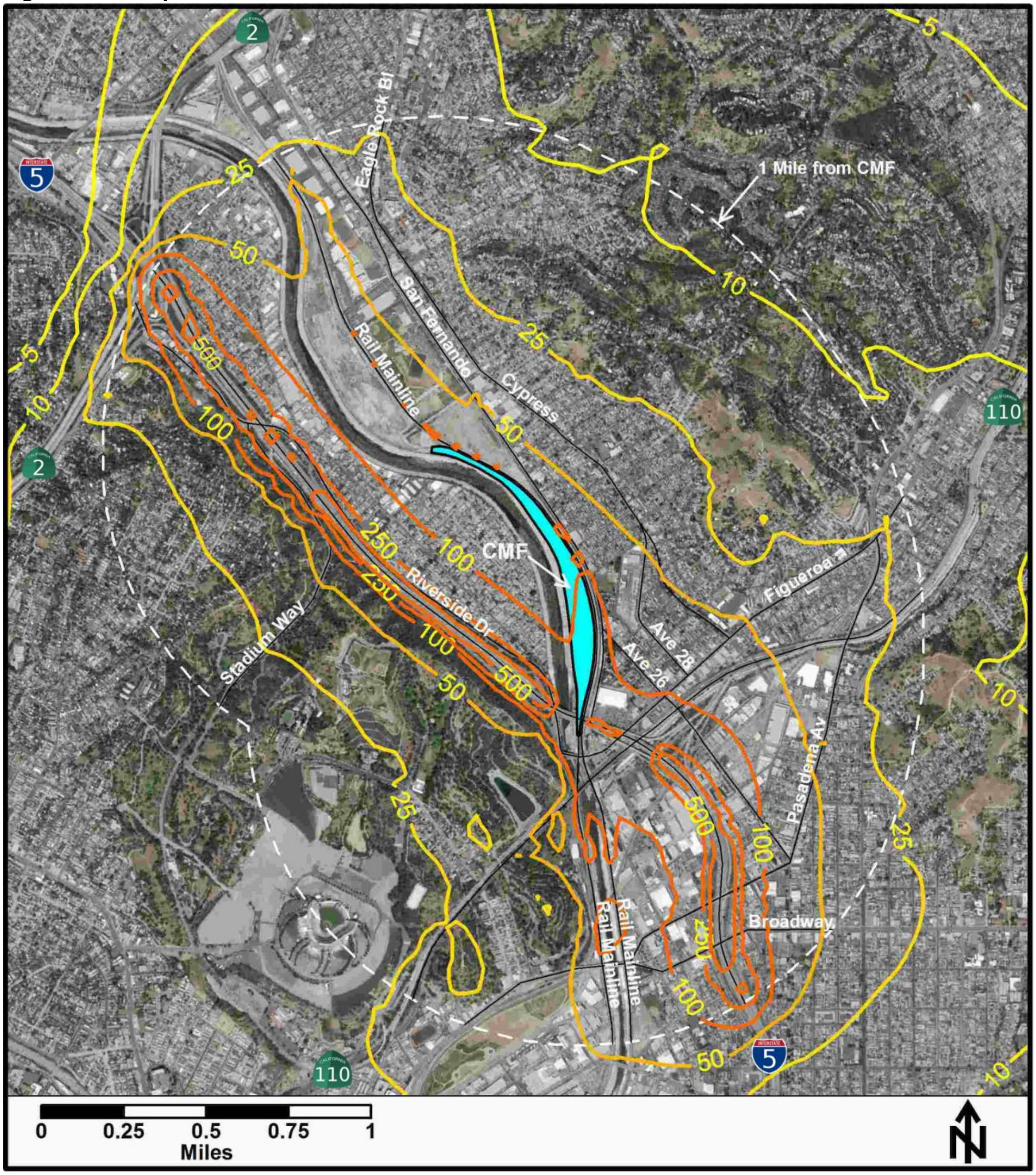
Table 5-6. Maximum Estimated Cancer Risks Associated with Off-Site Sources

Receptor	Maximum Estimated Cancer Risk [1] (chances per million people)			
	2010	**2012**	**2014**	**2017**
$MEIR_{70}$	401	346	160	103
$MEIR_{30}$	172	148	69	44
MEIW	174	150	70	45
Sensitive	70	60	28	18
MICR	401	346	160	103
PMI	639	552	253	163
Change in $MEIR_{70}$ Relative to 2010	**--**	**-14%**	**-60%**	**-74%**

Notes:

1. The values reported in the table represent the locations with the highest estimated risk, which are near the I-5 freeway. See Figures 5-5 through 5-8 for maps of cancer risk in all locations in the study area.
2. $MEIR_{70}$ - Maximally-exposed individual resident (70-year exposure); evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day.
3. $MEIR_{30}$ - Maximally-exposed individual resident (30-year exposure); evaluated with an exposure of 24 hours per day, 350 days per year, for 30 years, and an 80th percentile breathing rate of 302 L/kg/day.
4. MEIW - Maximally-exposed individual worker; evaluated with an exposure of 8 hours per day, 245 days per year, for 40 years, and an occupational breathing rate of 447 L/kg/day (which equates to 149 L/kg per 8-hour day).
5. Sensitive - Maximally-exposed sensitive receptor.
6. MICR - Maximum individual cancer risk (the maximum of MEIR70, MEIR30, MEIW, and Sensitive).
7. PMI - Point of maximum impact (in this case it is unoccupied); evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day.
8. The cancer risks presented for each analysis year assume that year's diesel PM emissions remain constant for the entire exposure period.

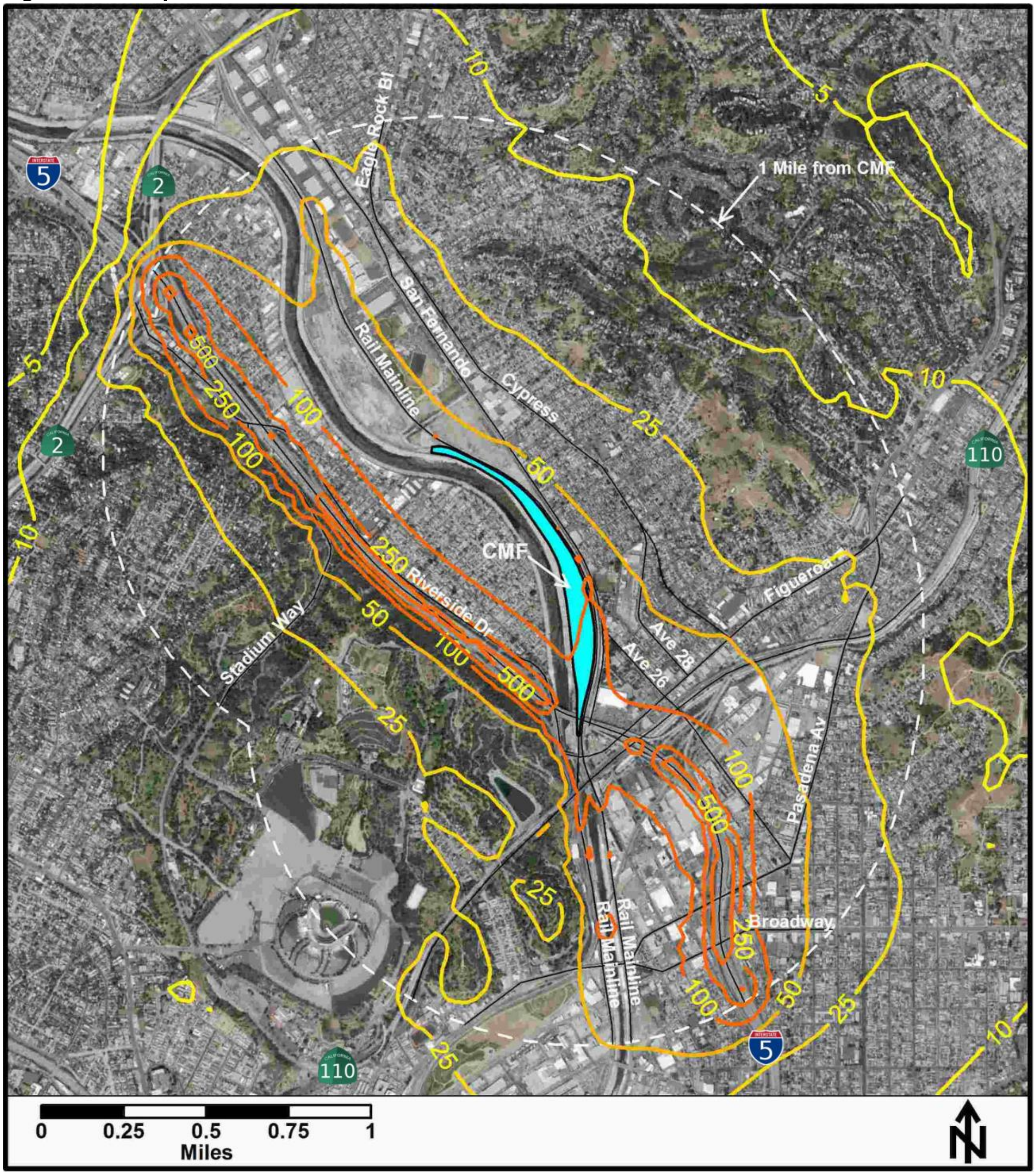
Figure 5-5. Isopleths of Individual Cancer Risk from Off-Site Sources – Year 2010



Notes:

1. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine MEIR70).
2. Cancer risks assume the Off-Site Sources diesel PM emissions within one mile of the CMF remain constant at 2010 levels for all 70 years of exposure.

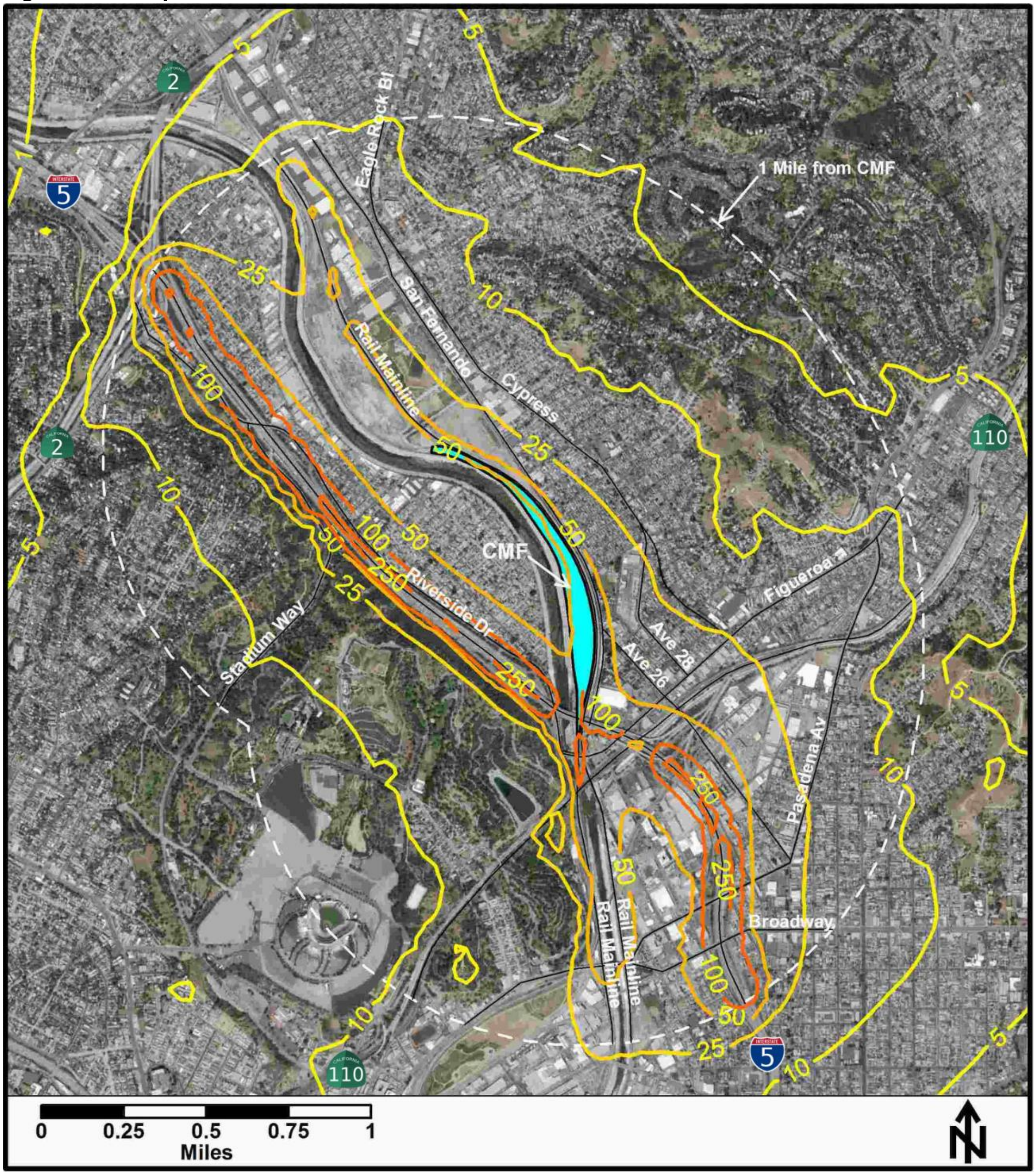
Figure 5-6. Isopleths of Individual Cancer Risk from Off-Site Sources – Year 2012



Notes:

1. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine MEIR70).
2. Cancer risks assume the Off-Site Sources diesel PM emissions within one mile of the CMF remain constant at 2012 levels for all 70 years of exposure.

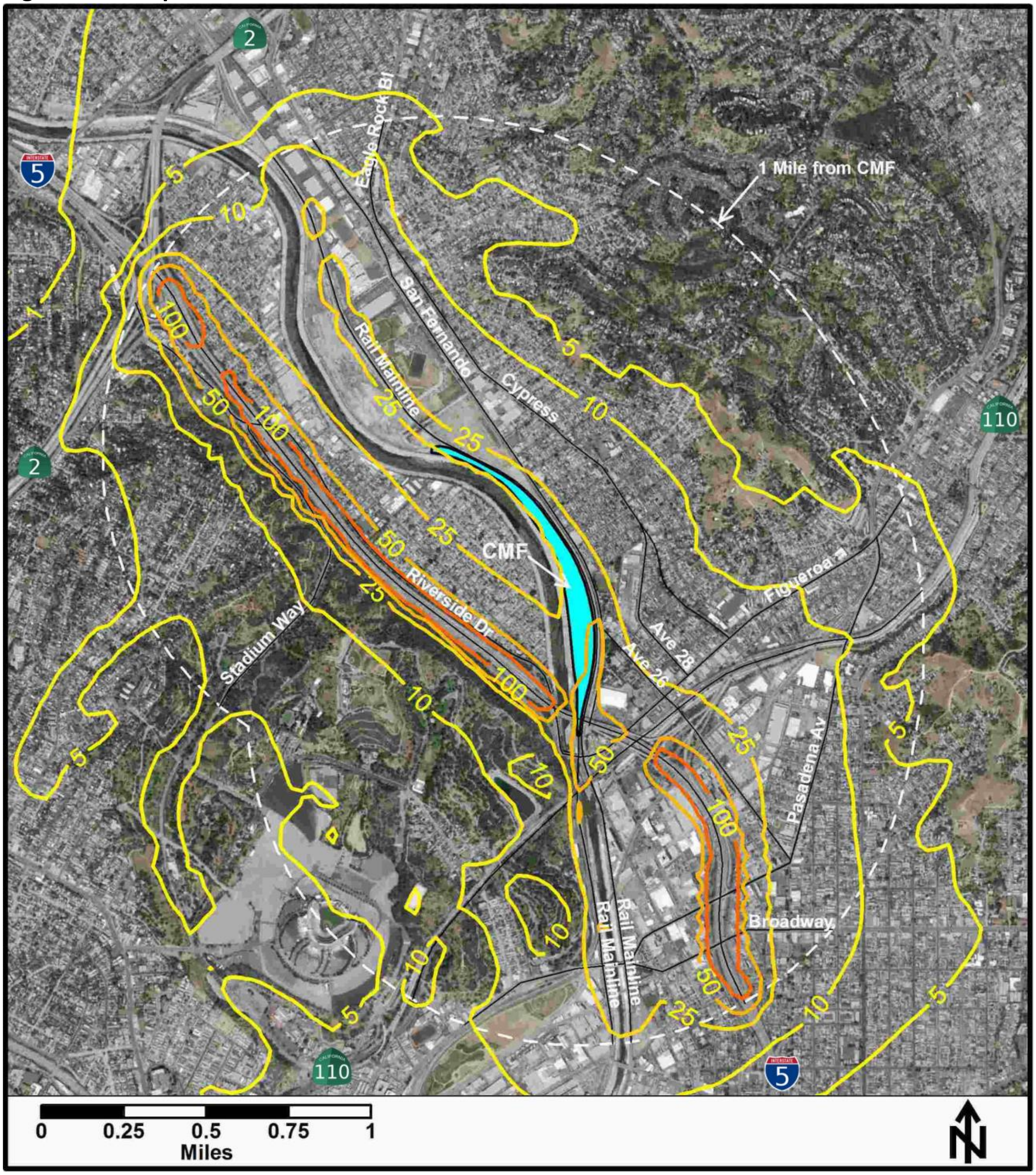
Figure 5-7. Isopleths of Individual Cancer Risk from Off-Site Sources – Year 2014



Notes:

1. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine MEIR70).
2. Cancer risks assume the Off-Site Sources diesel PM emissions within one mile of the CMF remain constant at 2014 levels for all 70 years of exposure.

Figure 5-8. Isopleths of Individual Cancer Risk from Off-Site Sources – Year 2017



Notes:

1. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine MEIR70).
2. Cancer risks assume the Off-Site Sources diesel PM emissions within one mile of the CMF remain constant at 2017 levels for all 70 years of exposure.

5.3.2 Chronic Hazard Indices Associated with Off-Site Sources

Table 5-7 presents the maximum estimated chronic hazard indices associated with off-site diesel PM emissions. The table shows that the hazard indices are less than 1.0 at all modeled receptors in all analysis years. According to OEHHA guidelines (OEHHA, 2003), these levels indicate that the off-site sources within one mile of the CMF are not expected to cause a substantial non-cancer health risk to the public from diesel PM above the background risk level that already exists throughout the South Coast Air Basin. The chronic hazard indices show a similar declining trend as the cancer risk values, achieving a reduction of 74 percent by 2017 compared to 2010.

Table 5-7. Maximum Estimated Chronic Hazard Indices Associated with Off-Site Sources

Receptor	Maximum Estimated Chronic Hazard Index [1]			
	2010	2012	2014	2017
MEIR	0.25	0.22	0.10	0.06
MEIW	0.25	0.22	0.10	0.06
Sensitive	0.17	0.15	0.07	0.04
PMI	0.40	0.35	0.16	0.10
Change in MEIR Relative to 2010	**--**	**-14%**	**-60%**	**-74%**

Notes:

1. The values reported in the table represent the locations with the highest estimated hazard indices, which are near the I-5 freeway.
2. MEIR - Maximally-exposed individual resident.
3. MEIW - Maximally-exposed individual worker.
4. Sensitive - Maximally-exposed sensitive receptor.
5. PMI - Point of maximum impact (in this case it is unoccupied).

5.3.3 Impacted Areas and Population Associated with Off-Site Sources

Table 5-8 presents the estimated number of acres and residents exposed to various ranges of cancer risks associated with off-site diesel PM emissions. The cancer risks used to determine the quantities in the table reflect 70-year residential exposure assumptions (i.e., the same assumptions used to evaluate $MEIR_{70}$). Table 5-8 shows that, from 2010 to 2017, both the geographical area and number of persons exposed to each range of cancer risk will decrease substantially. For example, the geographical area exposed to a 70-year residential cancer risk greater than or equal to 10 in a million will decrease from 8,047 acres in 2010 to 1,994 acres in 2017, a decrease of 75 percent. Similarly, the number of persons exposed to a 70-year residential cancer risk greater than or equal to 10 in a million will decrease from 158,201 persons in 2010 to 27,586 persons in 2017, a decrease of 83 percent.

5.3.4 Impacted Sensitive Receptors Associated with Off-Site Sources

Table 5-9 presents the number of modeled sensitive receptors exposed to various ranges of cancer risks associated with off-site diesel PM emissions. Each of the 37 sensitive receptors was modeled with the exposure assumptions appropriate for its receptor classification (child care, medical, school, or recreational), as described above in Section 5.1.1. Table 5-9 shows that in 2010, 15 sensitive receptors were exposed to a cancer risk less than or equal to 10 in a million, 12 were exposed to a cancer risk between 11 and 25 in a million, six were exposed to a cancer risk between 26 and 50 in a million, and four were exposed to a cancer risk between 51 and 100 in a million. By 2017, 31 sensitive receptors will be exposed to a cancer risk less than or equal to 10 in a million, and six will be exposed to a cancer risk between 11 and 25 in a million. The estimated cancer risk at each modeled sensitive receptor is provided in Appendix E.

Table 5-8. Estimated Impacted Areas and Population Exposed to Various Cancer Risk Levels from Off-Site Sources

Cancer Risk Range (per million)	Estimated Impacted Area (acres)				Estimated Exposed Population (persons)			
	2010	2012	2014	2017	2010	2012	2014	2017
10-25	5,316	4,617	1,722	1,216	121,657	99,280	29,532	20,338
26-50	1,381	1,194	737	530	21,728	19,061	9,060	6,084
51-100	783	734	347	151	9,011	7,519	4,028	1,164
101-250	392	306	157	97	5,495	4,171	314	0
> 250	173	148	22	0	310	175	0	0
Total ≥ 10	**8,047**	**6,998**	**2,985**	**1,994**	**158,201**	**130,206**	**42,934**	**27,586**
Change Relative to 2010	**--**	**-13%**	**-63%**	**-75%**	**--**	**-18%**	**-73%**	**-83%**

Notes:

1. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine MEIR70).
2. The cancer risks for each analysis year assume that year's diesel PM emissions from Off-Site Sources within one mile of the CMF remain constant for the entire exposure period.
3. The cancer risk ranges displayed in the table were selected for the purposes of comparison and discussion. The 10-per-million level was selected as the lowest range of cancer risk in the table because this level of risk is predicted to occur roughly on a local community scale.

Table 5-9. Estimated Number of Sensitive Receptors Exposed to Various Cancer Risk Levels from Off-Site Sources

Cancer Risk Range (per million)	No. of Sensitive Receptors			
	2010	2012	2014	2017
0-10	15	16	26	31
11-25	12	13	8	6
26-50	6	5	3	0
51-100	4	3	0	0
101-250	0	0	0	0
> 250	0	0	0	0

Notes:

1. The cancer risks for each analysis year assume that year's diesel PM emissions from Off-Site Sources remain constant for the entire exposure period.
2. Modeled sensitive receptors are within one mile of the CMF.
3. The cancer risk ranges displayed in the table were selected for the purposes of comparison and discussion.

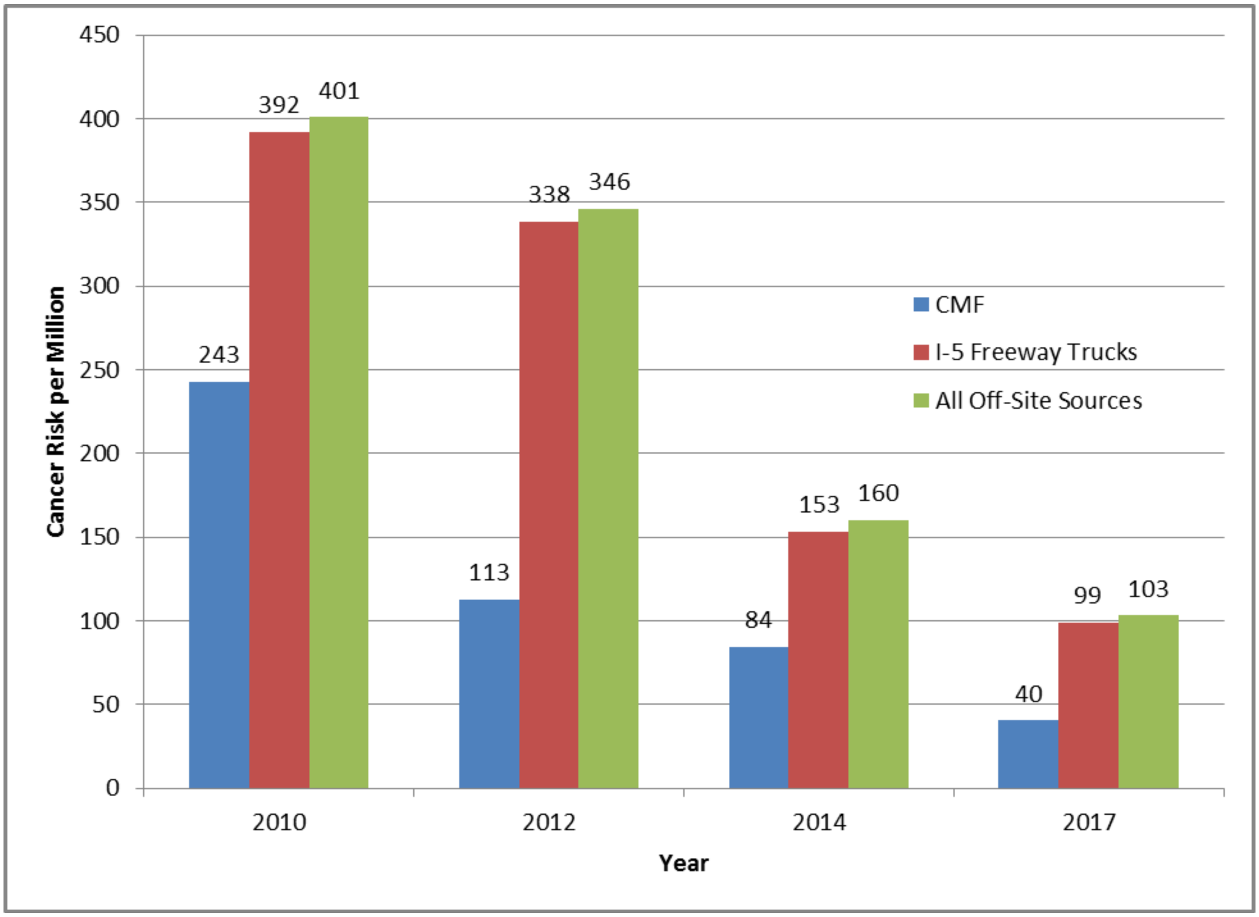
5.4 Comparison of Health Risks from CMF and Off-Site Sources

Figure 5-9 shows a graphical comparison of the maximally exposed individual residents with 70 years exposure ($MEIR_{70}$) estimated for the CMF and off-site sources. The displayed cancer risk values reflect 70-year residential exposure assumptions. Because diesel truck traffic on I-5 is such a dominant contributor to the risk from off-site sources, I-5 is shown by itself in the chart. I-5 is also included in the risks shown for "All Off-Site Sources".

Figure 5-9 shows that, in each analysis year, the CMF generates less cancer risk than either I-5 by itself or all off-site sources combined at their respective maximum cancer risk locations. The chart also shows that the declining trend in CMF cancer risk is more rapid than the declining trend in off-site sources risk. For example, in 2010, the CMF cancer risk is 61 percent as great as the off-site sources risk. By 2017, the CMF cancer risk is 39 percent of the off-site sources risk. This rapid decline in CMF cancer risk is a direct result of the emission reduction measures put into place by Metrolink at the CMF.

Figure 5-10 shows a graphical comparison of the number of residents exposed to a cancer risk greater than or equal to 10 in a million estimated for the CMF and off-site sources. The 10-per-million level was selected as a lower threshold of cancer risk in the figure because this level of risk is predicted to occur roughly on a local community scale. The exposed populations were determined based on 70-year residential exposure assumptions (i.e., the same assumptions used to evaluate $MEIR_{70}$). Figure 5-10 shows that, in each analysis year, the CMF exposes much fewer residents to a cancer risk greater than or equal to 10 in a million than the off-site sources within one mile of the CMF. For example, in 2010, the CMF is estimated to expose 11,453 residents to a cancer risk greater than or equal to 10 in a million, while the off-site sources are estimated to expose 158,201 residents. By 2017, the CMF is estimated to expose 2,775 residents to a cancer risk greater than or equal to 10 in a million, while the off-site sources are estimated to expose 27,586 residents.

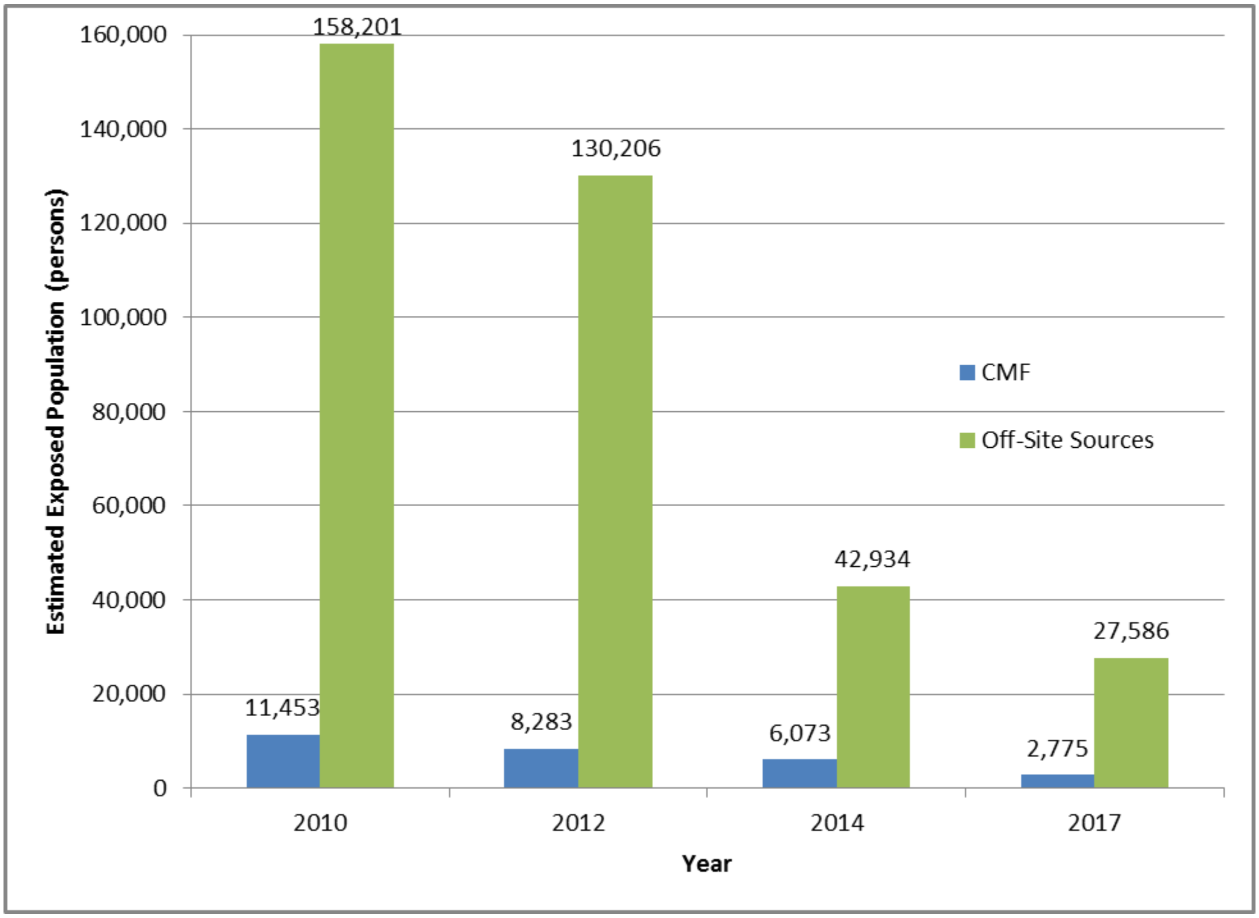
Figure 5-9. Comparison of Maximum Individual Cancer Risks (MICR) from the CMF and Off-Site Sources



Notes:

1. The values reported in the chart represent the locations with the highest estimated cancer risk for each displayed source category. These maximum risk locations are near the CMF boundary for the CMF HRA, and near I-5 for the off-site sources HRA. See Figures 5-1 through 5-8 for maps of cancer risk in all locations throughout the study area.
2. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine MEIR70).
3. Cancer risks from the CMF are associated with on-site diesel PM emissions.
4. Cancer risks from Off-Site Sources are associated with diesel PM emissions occurring within one mile of the CMF.
5. I-5 Freeway Trucks are shown as their own category and are also included in the "All Off-Site Sources" category.
6. The cancer risks for each analysis year assume that year's diesel PM emissions remain constant for the entire 70-year exposure period.
7. The category "All Off-Site Sources" includes diesel trucks and trains operating within one mile of the CMF, excluding emissions within the CMF. Diesel trucks were modeled on I-5, SR-110, San Fernando Rd., Riverside Dr., Figueroa St., Cypress Ave., Pasadena Ave., Stadium Way, W. Ave. 26, W. Ave. 28, N. Broadway, and Eagle Rock Blvd. Trains include Metrolink, Amtrak, and freight trains traveling on the rail mainlines.

Figure 5-10. Comparison of Population Exposed to a Cancer Risk ≥ 10 per Million from the CMF and Off-Site Sources



Notes:

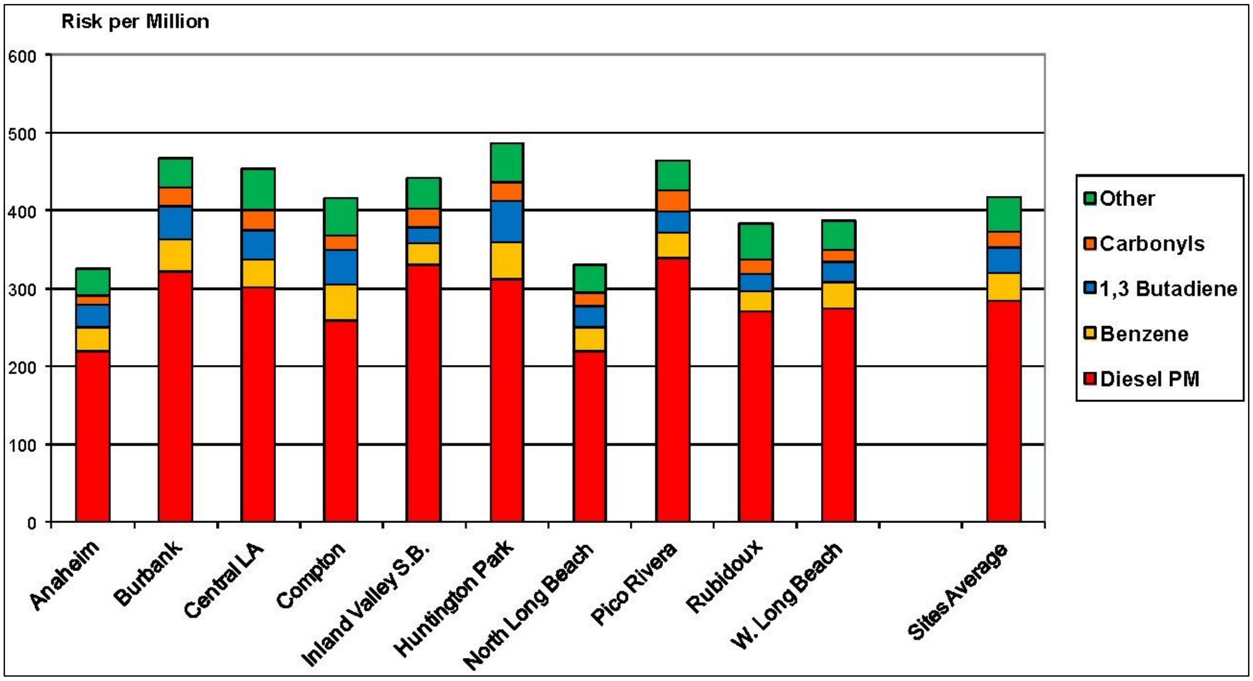
1. Cancer risks were evaluated with an exposure of 24 hours per day, 350 days per year, for 70 years, and an 80th percentile breathing rate of 302 L/kg/day (the same exposure assumptions used to determine MEIR70).
2. Cancer risks from the CMF are associated with on-site diesel PM emissions.
3. Cancer risks from Off-Site Sources are associated with diesel PM emissions occurring within one mile of the CMF.
4. The cancer risks for each analysis year assume that year's diesel PM emissions remain constant for the entire 70-year exposure period.
5. The 10-per-million level was selected as a lower threshold of cancer risk in the figure because this level of risk is predicted to occur roughly on a local community scale.

5.5 Background Cancer Risk

It is important to note that the risk levels presented in this report for the CMF and the off-site sources within one mile of the CMF represent just a portion of the overall background risk levels in the South Coast Air Basin. For example, the *Multiple Air Toxics Exposure Study IV* (MATES-IV) is a Basin-wide monitoring and evaluation study released as a draft report by the SCAQMD in 2014. One component of MATES-IV is the measurement of ambient concentrations of toxic air contaminants at 10 fixed sites throughout the Basin from July 2012 through June 2013. The estimated cancer risks at each of the 10 fixed sites are presented in Figure 5-11. The closest fixed site to the CMF is Central LA (CELA), the same site where the meteorological data used in the CMF HRA were collected. MATES-IV estimated that the cancer risk at the CELA site (from all toxic air contaminant emission sources in the Basin) is about 450 per million, and the average cancer risk across all 10 fixed sites is about 418 per million. Approximately 68 percent of the basin-wide risk is attributed to diesel PM (SCAQMD, 2014d).

Another component of MATES-IV is a modeling effort to estimate the risk everywhere in the Basin in 2 km grid cells. The modeling grid cell containing the largest portion of the CMF and surrounding neighborhoods was estimated by MATES-IV to have a cancer risk (from all toxic air contaminant emission sources in the Basin) of about 423 in a million (SCAQMD 2014e).

Figure 5-11. Background Cancer Risk Levels as Determined by the South Coast AQMD



Notes:

1. Source: MATES-IV Draft Report (SCAQMD 2014d), Figure ES-2.
2. Risks are based on actual monitored toxic air contaminant concentrations from July 2012 through June 2013 at 10 fixed sites in the South Coast Air Basin.
3. All mobile and stationary sources of toxic air contaminant emissions throughout the South Coast Air Basin contribute to these estimated risks.

The SCAQMD, in the MATES-IV report (SCAQMD, 2014d), also provides the following discussion to provide some perspective on risk estimates: "…it is often helpful to compare the risks estimated from assessments of environmental exposures to the overall rates of health effects in the general population. For example, it is often estimated that the incidence of cancer over a lifetime in the U.S. population is in the range of 1 in 4 to 1 in 3. This translates into a risk of about 250,000 to 300,000 in a million. It has also been estimated that the bulk of cancers from known risk factors are associated with lifestyle factors such as tobacco use, diet, and being overweight. One such study, the Harvard Report on Cancer Prevention, estimated that of all cancers associated with known risk factors, about 30% were related to tobacco, about 30% were related to diet and obesity, and about 2% were associated with environmental pollution related exposures."

5.6 Uncertainties and Limitations

Health risk assessment is a complex process that is based on current knowledge and a number of assumptions. Therefore, there is uncertainty associated with the process of risk assessment. The uncertainty arises from lack of data in many areas, necessitating the use of assumptions. The assumptions used in the assessment are often designed to be conservative on the side of health protection in order to avoid underestimation of risk to the public. As indicated by the OEHHA guidelines (OEHHA, 2003), risk assessments are useful in comparing risks among a number of facilities and similar sources. Thus, the risk estimates should not be interpreted as a literal prediction of disease incidence in the affected communities, but more as a tool for comparison of the relative risk between one facility and another. They are also an effective tool for determining the impact a particular emission reduction strategy will have on reducing risks (CARB, 2007).

As described previously, the health risk assessment consists of three components: emissions assessment, air dispersion modeling, and health risk assessment. Each component has a certain degree of uncertainty associated with its estimation and prediction due to the assumptions made and analysis tools used. Therefore, there are uncertainties and limitations with the results. The following subsections, adapted from the CARB Rail Yard HRAs (CARB, 2007), describe the specific sources of uncertainties in each component. In combination, these various factors may result in potential uncertainties in the location and magnitude of predicted concentrations, as well as the potential health effects actually associated with a particular level of exposure.

Emissions Assessment

The emission rate often is considered to be proportional to the type and magnitude of the activity at a source, e.g., the operation. Ideally, emissions from a source can be calculated on the basis of measured concentrations of the pollutant in the sources and emission strengths, e.g., a continuous emission monitor. This approach can be very costly and time consuming and is not often used for the emission estimation. Instead, emissions are usually estimated by the operation activities or fuel consumption and associated emission factors, based usually on source tests.

The uncertainties of emission estimates may be attributed to many factors such as a lack of information for variability of locomotive engine type, throttle setting, level of maintenance, operation time, and emission factor estimates. For locomotive sources at the CMF, the activity rates include primarily the number of engines in operation and the time spent in different power settings. The methodology used for the locomotive emissions is based on these facility-specific activity data. The number of engines operating in the facility is generally well-tallied by Metrolink. Uncertainties also exist in estimates of the engine time in mode.

As discussed previously, emission factors are often used for emission estimates according to different operating cycles. For this study, a significant effort was made to obtain the best available locomotive emission factors based on source tests conducted on similar locomotive models (in some cases, Metrolink locomotives). However, the emission factors for each locomotive model are usually based on tests done on a single locomotive, resulting in uncertainty in the emission factors.

For non-locomotive emissions, including HEP engines, yard equipment, and on-road vehicles, uncertainty also exists because the duty cycles (i.e., engine load demanded) are less well-characterized. Default estimates of the duty cycle parameters may not accurately reflect the typical duty demanded from these vehicles and equipment at any particular site. In addition, CARB emission factor models are normally used to determine emission factors based on the average Basin-wide equipment fleets.

Air Dispersion Modeling

Dispersion models are a simplified mathematical representation of a real-world system. Uncertainties arise from the model's inability to represent a complex aerodynamic process. An air dispersion model usually uses simplified atmospheric conditions to simulate pollutant transport in the air, and these conditions become inputs to the models (e.g., the use of non-site-specific meteorological data, uniform wind speed over the simulating domain, use of surface parameters for the meteorological station as opposed to the rail yard, substitution of missing meteorological data, and simplified emission source representation). There are also other physical dynamics in the transport process, such as the small-scale turbulent flow in the air, which are not characterized by the air dispersion models. As a result of the simplified representation of real-world physics, deviations in pollutant concentrations predicted by the models may occur due to the introduced uncertainty sources.

Uncertainties in air dispersion models have been improved over the years because of better representations in the model structure. In 2006, the U.S. EPA modeling guidance was updated to replace the Industrial Source Complex model with AERMOD as a recommended regulatory air dispersion model for single sources and source complexes. Many updated formulations have been incorporated into the model structure from its predecessor for better predictions from the air dispersion process. Nevertheless, quantifying overall uncertainty of model predictions is infeasible due to the associated uncertainties described above, and is beyond the scope of this study.

Health Risk Assessment

The toxicity of toxic air contaminants is often established by available epidemiological studies, or, where data from humans are not available, the use of data from animal studies. The diesel PM cancer potency factor is based on long-term study of rail yard workers exposed to diesel exhaust at concentrations approximately ten times typical ambient exposures (OEHHA, 2003). The differences within human populations usually cannot be easily quantified and incorporated into risk assessments. Factors including metabolism, target site sensitivity, diet, immunological responses, and genetics may influence the response to toxicants. In addition, the human population is much more diverse both genetically and culturally (e.g., lifestyle, diet) than inbred experimental animals. The intraspecies variability among humans is expected to be much greater than in laboratory animals. Adjustment for tumors at multiple sites induced by some carcinogens could result in a higher potency. Other uncertainties arise (1) in the assumptions underlying the dose-response model used, and (2) in extrapolating from large experimental doses, where, for example, other toxic effects may compromise the assessment of carcinogenic potential due to much smaller environmental doses. Also, only single tumor sites induced by a substance are usually considered. When epidemiological data are used to generate a carcinogenic potency, less uncertainty is involved in the extrapolation from workplace exposures to environmental exposures. However, children, whose hematological, nervous, endocrine, and immune systems are still developing and who may be more sensitive to the effects of carcinogens, are not included in the worker population and risk estimates based on occupational epidemiological data are more uncertain for children than adults.

Human exposures to diesel PM are based on limited availability of data and are mostly derived based on estimates of emissions and duration of exposure. Different epidemiological studies also suggest somewhat different levels of risk. When the Scientific Review Panel identified diesel PM as a toxic air contaminant (ARB, 1998), the panel members endorsed a range of inhalation cancer potency factors and a risk factor as a reasonable estimate of the unit risk. From the unit risk factor an inhalation cancer potency factor of 1.1 $(mg/kg\text{-}day)^{-1}$ can be calculated, which was used in the study. There are many epidemiological studies that support the finding that diesel exhaust exposure elevates relative risk for lung cancer. However, the quantification of each uncertainty applied in the estimate of cancer potency is very difficult and can be itself uncertain.

This study adopts the standard Tier 1 approach recommended by OEHHA for exposure and risk assessment. A Tier 1 approach is an end-point estimate methodology without the consideration of site-specific data distributions. It also assumes that an individual is exposed to an annual average concentration of a pollutant continuously for a specific time period. OEHHA recommends the lifetime 70-year exposure duration with a 24-hour per day exposure be used for determining residential cancer risks. This will ensure a person residing in the vicinity of a facility for a lifetime will be included in the evaluation of risk posed by the facility. Lifetime 70-year exposure is a conservative estimate, but is the historical benchmark for comparing facility impacts on receptors and for evaluating the effectiveness of air pollution control measures. Although it is not likely that most people will reside at a single residence for 70 years, it is common that people will spend their entire lives in a major urban area. While residing in urban areas, it is very possible to be exposed to the emissions of another facility at the next residence. In order to help ensure that people do not accumulate an excess unacceptable cancer risk from cumulative exposure to stationary facilities at multiple residences, the 70-year exposure duration is used for risk management decisions. However, if a facility is notifying the public regarding health risk, it is a useful indication for a person who has resided in his or her current residence for less than 70 years to know that the calculated estimate of his or her cancer risk is less than that calculated for a 70-year risk (OEHHA, 2003). It is important that the risk estimates generated in this study not be interpreted as the expected rates of disease in the exposed population, but rather as estimates of potential risk. Risk assessment is best viewed as a comparative tool rather than a literal prediction of diesel incidence in a community.

Moreover, since the Tier-1 methodology is used in the study for the health risk assessment, the results have been limited to deterministic estimates based on conservative inputs. For example, an 80th percentile breathing rate approach is used to represent a 70-year lifetime inhalation that tends toward the high end for the general population. Moreover, the results based on the Tier-1 estimates do not provide an indication of the magnitude of uncertainty surrounding the quantities estimated, nor an insight into the key sources of underlying uncertainty.

6. Conclusions

In response to concerns raised by residents of surrounding communities, Metrolink has voluntarily prepared a health risk assessment of diesel PM emissions released from its Central Maintenance Facility (CMF). Diesel PM is the dominant toxic air contaminant in and around a rail yard. As supplemental information for purposes of comparison, the HRA also estimated potential health risks from significant off-site emission sources within one (1) mile of the CMF.

The CMF HRA was prepared using current risk assessment guidelines published by the California Office of Environmental Health Hazard Assessment (OEHHA, 2003) and rail yard-specific supplemental guidelines published by the California Air Resources Board (CARB, 2006). The HRA evaluated emissions associated with four different analysis years (2010, 2012, 2014, and 2017) representing different stages of implementation of Metrolink's voluntary emission reduction measures at the CMF. The HRA estimated cancer risks and chronic non-cancer hazard indices under several different human exposure scenarios. From a risk management perspective, CARB staff believes it is reasonable to focus an HRA on diesel PM cancer risk because it is the predominant risk driver, and the most effective parameter to evaluate risk reduction actions (CARB 2007).

The emissions assessment estimated that CMF emissions will decline 79 percent from 2010 to 2017 in response to the voluntary emission reduction measures implemented at the CMF by Metrolink. Off-site source emissions will also decline substantially from 2010 to 2017, although not as rapidly as the CMF emissions. The CMF emissions are less than the off-site source emissions within one mile of the CMF for each of the four analysis years. The CMF contributed 38 percent of the total CMF plus off-site source emissions in 2010. By 2017, the CMF will contribute just 30 percent of the total emissions.

The health risk assessment estimated that the cancer risk associated with CMF diesel PM emissions will decline 83 percent, from 243 in a million in 2010 to 40 in a million in 2017, at the maximally exposed 70-year residential receptor. The number of persons exposed to a CMF cancer risk greater than or equal to 10 in a million will decline 76 percent, from 11,453 persons in 2010 to 2,775 persons in 2017. The cancer risk at all modeled sensitive receptors will be less than 10 in a million by 2017.

The cancer risk associated with off-site source diesel PM emissions will decline 74 percent, from 401 in a million in 2010 to 103 in a million in 2017, at the maximally exposed 70-year residential receptor. The number of persons exposed to an off-site sources cancer risk greater than or equal to 10 in a million will decline 83 percent, from 158,201 persons in 2010 to 27,586 persons in 2017. By 2017, the cancer risk will be less than 10 in a million at 31 modeled sensitive receptors, and between 11 and 25 in a million at 6 modeled sensitive receptors. Interstate 5 is the dominant off-site source of cancer risk.

In each analysis year, the CMF generates less cancer risk than either I-5 by itself or all off-site sources combined at their respective maximum cancer risk locations. In addition, the declining trend in CMF cancer risk is more rapid than the declining trend in off-site sources risk. For example, in 2010, the CMF cancer risk is 61 percent as great as the off-site sources risk at their respective maximum cancer risk locations. By 2017, the CMF cancer risk is just 39 percent of the off-site sources risk. This rapid decline in CMF cancer risk is a direct result of the emission reduction measures put into place by Metrolink at the CMF.

Health risk assessment is a complex process that is based on current knowledge and a number of assumptions. Therefore, there is uncertainty associated with the process of risk assessment. The assumptions used in the assessment are often designed to be conservative on the side of health protection in order to avoid underestimation of risk to the public. As indicated by the OEHHA guidelines (OEHHA, 2003), risk assessments are useful in comparing risks among a number of facilities and similar sources. Thus, the risk estimates should not be interpreted as a literal prediction of disease incidence in the affected communities, but more as a tool for comparison of the relative risk between one facility and another. They are also an effective tool for determining the impact a particular emission reduction strategy will have on reducing risks.

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Appendix A

Health Risk Assessment Protocol for the CMF

Final
Health Risk Assessment Protocol
for the Central Maintenance Facility

Prepared for:

METROLINK®

Prepared by:

Castle Environmental Consulting, LLC

June 20, 2014

Introduction

In response to concerns raised by the residents of the surrounding communities, Metrolink will prepare a health risk assessment (HRA) of toxic air contaminant emissions released from its Central Maintenance Facility (CMF). The CMF is Metrolink's primary maintenance facility for its fleet of locomotives and rail cars. The CMF is located on the property that had been Southern Pacific's Taylor Yard in the community of Cypress Park (Figure 1). Metrolink has been servicing trains at the CMF since 1991, while Taylor Yard first began operating as a rail yard in the 1920s.

This protocol describes the methodology for conducting the CMF HRA. It has been revised since the draft version in response to comments received from the South Coast Air Quality Management District (AQMD), community members, the Los Angeles Unified School District, and elected officials. The purpose of the HRA will be to estimate the potential health risk of CMF emissions to people living and working in the neighborhoods surrounding the CMF. The HRA will also estimate the effects on health risk resulting from various emission reduction measures being implemented at the CMF by Metrolink. As supplemental information, the HRA will also estimate the potential health risk of off-site emission sources near the CMF. The CMF HRA will be prepared by Metrolink's consultant, Castle Environmental Consulting (CEC), in consultation with the AQMD.

The CMF HRA will be patterned after 17 other HRAs for major California rail yards, prepared by the California Air Resources Board (CARB) in 2007, pursuant to a 2005 agreement with the Class I railroads.[1] These CARB rail yard HRAs established the industry standard for rail yard HRAs and were prepared in accordance with risk assessment guidelines that remain in effect.[2,3] Using this same approach for the CMF HRA will ensure a consistent, reliable, and previously validated methodology, and will allow for a meaningful comparison of the results to those of other rail yards in the region.

Consistent with the CARB rail yard HRAs, the CMF HRA will evaluate health risks associated with diesel particulate matter (DPM) emissions generated within the CMF boundary. From a risk management perspective, CARB staff believes it is reasonable to focus on DPM cancer risk because it is the predominant risk driver, and the most effective parameter to evaluate risk reduction actions. Moreover, actions to reduce DPM will also reduce non-cancer risks.[4]

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[1] The CARB rail yard HRAs can be found at http://www.arb.ca.gov/railyard/hra/hra.htm.

[2] Office of Environmental Health Hazard Assessment (OEHHA), 2003. *Air Toxics Hot Spots Program Risk Assessment Guidelines. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*. Website: http://oehha.ca.gov/air/hot_spots/HRAguidefinal.html. August.

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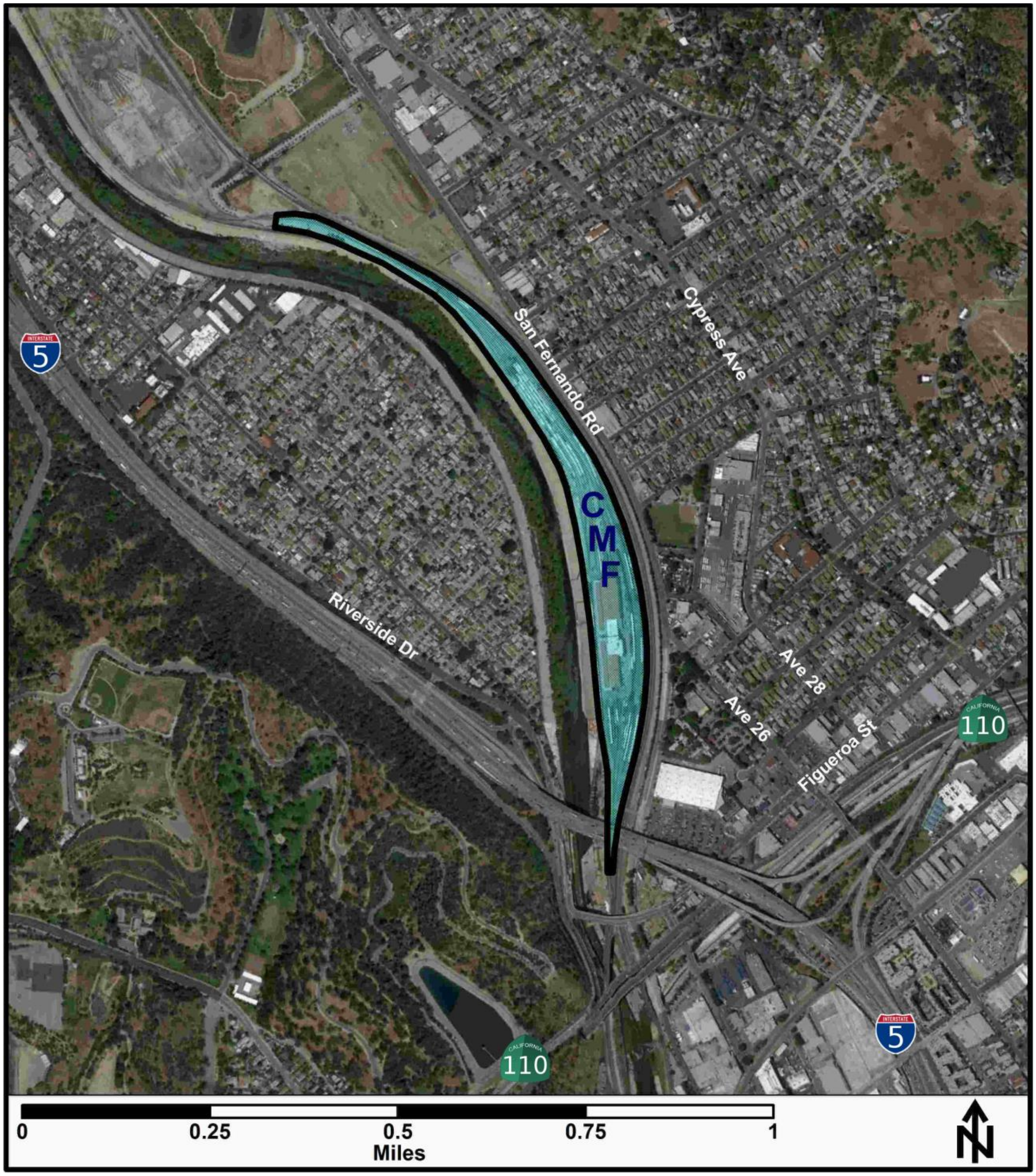

Figure 1. Central Maintenance Facility

General Overview of Health Risk Assessments

The following health risk assessment overview is adapted from the CARB rail yard HRAs.[5]

An HRA uses mathematical models to evaluate the health risks from exposure to certain chemicals or toxic air contaminants released from a facility or found in the air. HRAs provide information to estimate potential long-term cancer and non-cancer health risks. HRAs do not gather information or health data on specific individuals, but are estimates for the potential health risks to a population at large.

An HRA consists of three major components: an air pollution emission inventory, air dispersion modeling, and an assessment of associated health risks. The air pollution emission inventory provides an understanding of how the air toxics are generated and emitted.[6] The air dispersion modeling takes the emission inventory and meteorological data such as temperature and wind speed/direction as its inputs, and uses a computer model to predict the distributions of air toxics in the air. Based on this information, an assessment of the potential health risks of the air toxics to an exposed population is performed. The results are expressed in a number of ways as summarized below.

The cancer risk associated with an activity is usually expressed as the number of chances in a population of a million people. For example, the number may be stated as "10 in a million" or "10 chances per million". If a population of one million people was exposed to the same potential cancer risk (e.g., 10 chances per million), then statistics would predict that no more than 10 of those million people exposed would be likely to develop cancer from a lifetime of exposure (i.e., 70 years) to toxic air contaminant emissions from a facility.

The methodology used to estimate the potential cancer risks is consistent with the Tier-1 analysis of *Air Toxics Hot Spots Program Risk Assessment Guidelines* (OEHHA, 2003). A "Tier-1" analysis assumes that an individual is exposed to an annual average concentration of a given pollutant continuously for 70 years. The length of time that an individual is exposed to a given air concentration is proportional to the risk. During childhood, the risk from exposure to a given air concentration is greater. Exposure durations of 30 years or 9 years may also be evaluated as supplemental information to present the range of cancer risk based on residency period.

For non-cancer health risk, a reference exposure level (REL)[7] is used to predict if there may be an increased risk of certain types of adverse health conditions, such as lung irritation, liver

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[5] CARB 2007.

[6] The emission inventory step is not described in detail here because Metrolink has already completed a draft CMF baseline emissions assessment for use in the HRA (pending final revisions in response to AQMD and community feedback).

[7] The reference exposure level for diesel PM is essentially the U.S. EPA Reference Concentration first developed in the early 1990s based on histological changes in the lungs of rats. Since the identification of diesel PM as a toxic air contaminant, California has evaluated the latest literature on particulate matter health effects to set the Ambient Air Quality Standard. Diesel PM is a component of particulate matter. Health effects from particulate matter in humans include illness and death from cardiovascular and respiratory disease, and exacerbation of asthma and other respiratory illnesses. Additionally, a body of literature has been published, largely after the identification of diesel PM as a toxic air contaminant and adoption of the reference exposure level, which shows that diesel PM can enhance allergic responses in humans and animals. Thus, it should be noted that the reference exposure level does

damage, or birth defects, after chronic (long-term) or acute (short-term) exposure. To calculate non-cancer health risk, the REL is compared to the concentration that a person is exposed to, and a hazard index is calculated. Typically, the greater the hazard index is above 1, the greater the risk of possible adverse health effects. If the hazard index is less than 1, adverse effects are less likely to happen.

The HRA is a complex process that is based on current knowledge and a number of assumptions. However, there is a certain extent of uncertainty associated with the process of risk assessment. The uncertainty arises from lack of data in many areas, necessitating the use of assumptions. The assumptions used in the assessment are often designed to be conservative on the side of health protection in order to avoid underestimation of risk to the public. As indicated by the Office of Environmental Health Hazard Assessment (OEHHA) Guidelines, the Tier-1 evaluation is useful in comparing risks among a number of facilities and similar sources. Thus, the risk estimates should not be interpreted as a literal prediction of disease incidence in the affected communities, but more as a tool for comparison of the relative risk between one facility and another. They are also an effective tool for determining the effect a particular control strategy will have on reducing risks.

CMF Health Risk Assessment Methodology

Consistent with the CARB rail yard HRAs, the CMF HRA will be prepared in accordance with the *Health Risk Assessment Guidance for Railyard and Intermodal Facilities* that the CARB staff developed in 2006, and the *Air Toxics Hot Spots Program Risk Assessment Guidelines* published by OEHHA in 2003.[8]

The CMF HRA will be based on a CMF baseline emissions assessment that is being prepared by CEC and Metrolink. A draft baseline emissions assessment was completed in June 2013 and was reviewed by the AQMD. The results of the draft baseline emissions assessment were presented to the community working group by CEC and Metrolink on June 27, 2013. The baseline emissions assessment covers all sources of DPM emissions at the CMF, including:

- Locomotive main engines – used during fueling, servicing, inspection, brake testing, car cleaning, load testing, yard switching, idling, and train movement throughout the yard.
- Locomotive head-end power (HEP) engines – used to provide electricity to the rail cars while not connected to ground power, and during maintenance load tests.
- Yard equipment – includes two emergency generators, two forklifts, a welder, and a diesel rail car mover.

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not reflect adverse impacts of particulate matter on cardiovascular and respiratory disease and deaths, exacerbation of asthma, and enhancement of allergic response.

[8] OEHHA is in the process of revising its risk assessment guidelines. The revised guidelines will include updated exposure parameters (e.g., inhalation rate, food consumption rate, etc.) based on the most recent data, including exposure factors for infants and children, in accordance with the mandate of the Children's Environmental Health Protection Act (Senate Bill 25, Escutia, Chapter 731, Statutes of 1999, Health and Safety Code Sections 39669.5 et seq.). The revised document also updates the approach to assessing dermal exposure. Results based on the revised guidelines will also be presented if approved by OEHHA and CARB prior to conducting the CMF HRA.

- On-Road Trucks – includes fuel trucks and vendor deliveries.

Prior to conducting dispersion modeling and assessment of health risks, the baseline emissions assessment will be finalized by CEC and Metrolink based on feedback from the AQMD and community working group.

Conditions to be Analyzed

CMF Emissions

The CMF HRA will evaluate health risks to the community associated with DPM emissions that occur within the CMF boundary. Health risk results will be calculated and reported separately for four different operational years: 2010, 2012, 2014, and 2017.[9] Year 2010 represents baseline operating conditions at the CMF prior to the implementation of the emission reduction measures described below for Years 2012, 2014, and 2017.

Year 2012 was the most recent complete year of operation at the time emissions were calculated. The following emission reduction measures were in place at the CMF in 2012 and therefore will be included in the 2012 evaluation:

- Fuel Conservation Program (FCP) – reduces the amount of time trains are idling by approximately 35%. The FCP includes the following elements:
    - Trains arrive at CMF with HEP engines off; main and HEP engines are subject to compliance program
    - Trains parked in Storage Yard with both engines shut down until 30 - 45 minutes before departure
    - Pilot ground power program for use of electric power in rail cars during testing and inspection (9 electric plug in stations)
    - Replaced diesel powered forklifts with electric powered forklifts
    - Increased AESS (Auto-Engine Start/Stop) equipped locomotives from 15 to 32
- Modified CMF yard operations to further reduce time being serviced, noise, and idling

Year 2014 represents future CMF conditions, after implementation of the following additional emission reduction measures:

- Reduction in the number of trains serviced at the CMF, from 31 to 26 weekday trains, due to startup of Metrolink's new Eastern Maintenance Facility (EMF) in Colton
- Expanded ground power program (5 additional electric plug in stations, for a total of 14) to provide electric power to rail cars during testing and inspection
- Purchase of a new electric rail car mover to perform yard switching operations

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[9] One difference between the CARB rail yard HRAs and the CMF HRA is that the former were based on 2005 emissions, while the latter will be based on 2010, 2012, 2014, and 2017 emissions.

Year 2017 represents future CMF conditions, after implementation of the following additional emission reduction measure:

- Purchase of 20 new locomotives meeting the most stringent (Tier 4) emission standards

Consistent with the CARB rail yard HRAs, the calculation of cancer risk will assume that the DPM emissions for a particular analysis year described above will remain constant, year after year, for the entire 70-year exposure period. This assumption is conservative because emissions will actually decrease with time as locomotives and other diesel equipment will be periodically replaced with newer, cleaner engines as they reach the end of their useful lives.

Off-Site Emission Sources

As supplemental information, the HRA will also evaluate the risks from off-site pollution sources near the CMF. Specifically, off-site mobile and stationary DPM emission sources located within 1 mile from the CMF boundary will be modeled.[10] Although not the primary focus of the CMF HRA, the health risks associated with the off-site pollution sources will provide another means (in addition to the CARB Rail Yard HRAs) by which the CMF health risk results can be compared and assessed.

Off-site emissions from vehicles on freeways and major streets will be based on measured traffic volumes and speeds from databases such as the Caltrans Performance Measurement System (PeMS)[11], Traffic Census[12], and other available data from SCAG, LADOT, and Metro. On-road vehicle emission factors will be obtained from CARB's EMFAC2011 model.[13] Off-site emissions from freight and passenger trains will be based on available operational profiles from Metrolink, Amtrak, Union Pacific, and the Federal Railroad Administration. Locomotive emission factors will be based on locomotive model-specific emissions data (where possible) and U.S. Environmental Protection Agency (EPA) fleet average locomotive emission factors.[14] Off-site stationary source DPM emissions will be obtained from the AQMD's Facility Information Detail (FIND) database.[15]

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[10] Although the off-site sources included in the HRA will be confined to the area shown in Figure 2, the receptor grid over which risks will be calculated will extend far outside this area, as shown in Figure 3.
[11] The Caltrans PeMS database can be found at http://pems.dot.ca.gov/.
[12] The Caltrans Traffic Census can be found at http://traffic-counts.dot.ca.gov/.
[13] The California Air Resources Board's EMFAC2011 model can be found at http://www.arb.ca.gov/msei/modeling.htm.
[14] Sources include EPA's *Technical Highlights: Emission Factors for Locomotives*, EPA-420-F-09-025, April 2009; and EPA's *Locomotive Emission Standards. Regulatory Support Document.* April 1998.
[15] The AQMD's FIND database can be found at https://www.aqmd.gov/webappl/fim/default.htm.

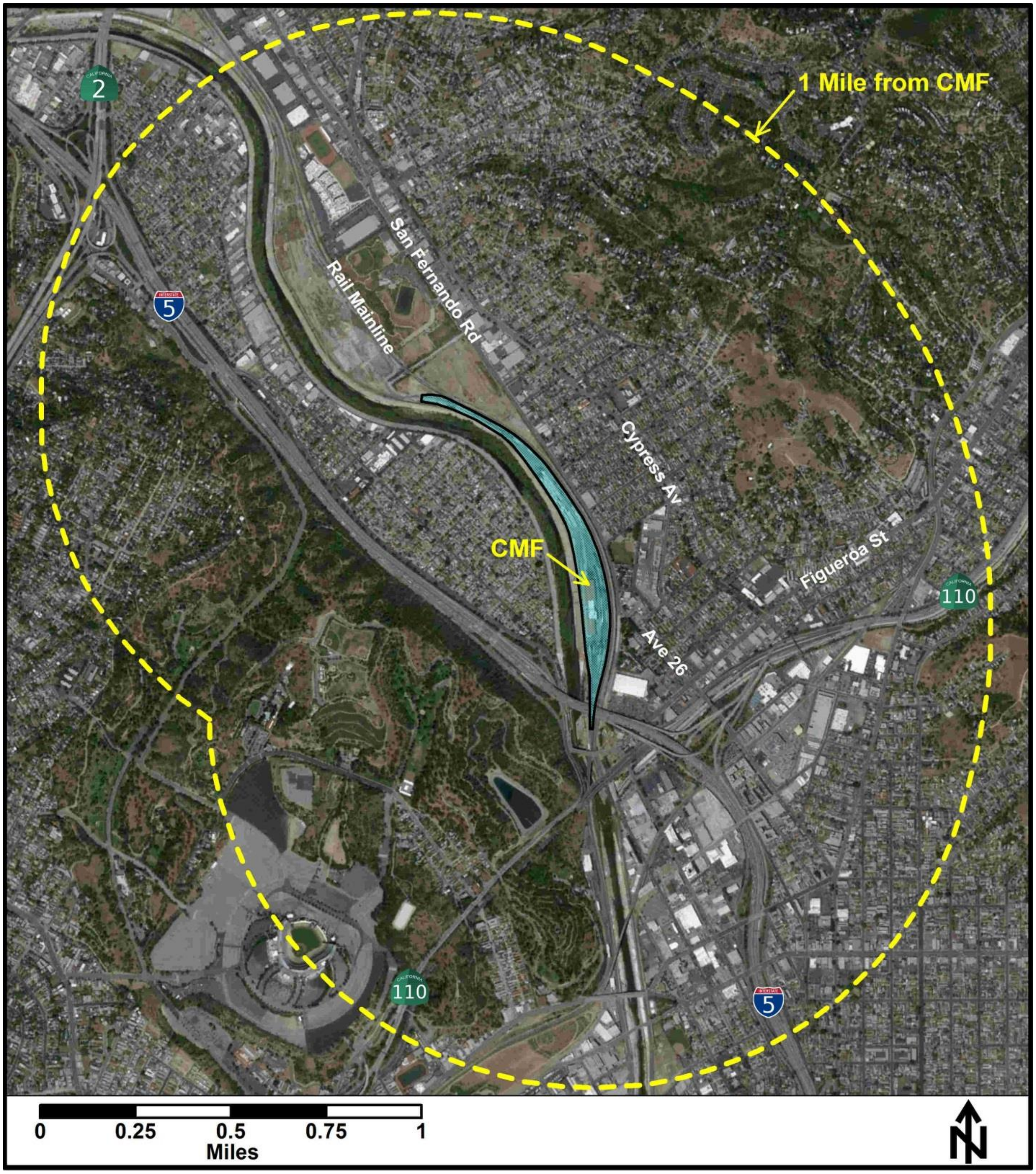


Figure 2. Area of Off-Site Sources to be Modeled

Dispersion Modeling

Prior to calculating health risks, CEC will perform dispersion modeling of the CMF on-site emission sources and the off-site emissions sources. The most recent version of the U.S. EPA dispersion model, AERMOD, will be used to predict annual DPM concentrations in the vicinity of the CMF. The model options used in AERMOD will be consistent with the CARB rail yard HRAs as described by CARB guidance.[16] The source parameters that will be used in AERMOD are presented in Table 1. In general, stationary sources will be simulated as point or volume sources, and moving sources will be simulated as line or area sources positioned along the travel paths or over the areas of activity. Aerodynamic wake effects of prominent buildings at the CMF will be simulated in AERMOD.

A grid of receptors will be developed in AERMOD suitable for producing health risk contours (isopleths) over the surrounding region and identifying the locations of maximally-exposed residential, occupational, and sensitive receptors. Consistent with the CARB rail yard HRAs, the coarse receptor grid will cover an area of 20 kilometers by 20 kilometers (approximately 12 miles by 12 miles), as shown in Figure 3. The receptor grid will be sufficiently dense to develop the 1, 10, 25, 50, 100, 250, 500, 1000, 2500, 5000, etc. in a million potential cancer risk isopleths and the 0.5, 1, 3, 5, and 10 non-carcinogenic chronic health hazard index isopleths. In addition, fine grids with 50-meter spacing will be modeled around maximally exposed areas to identify maximum risks at a 50-meter resolution. Sensitive receptors, including schools, child care centers, medical facilities, and convalescent homes within 1 mile of the CMF will also be modeled. Receptor elevations will be assigned in AERMOD using digital elevation maps of the modeling domain.

Pre-processed meteorological data sets compatible with AERMOD will be obtained from the South Coast AQMD. Given the complex geography of the project vicinity, the selection of the representative meteorological station will be made in partnership with the South Coast AQMD.

The same dispersion model (AERMOD), coarse receptor grid system, and meteorological data used for CMF air dispersion modeling will also be used for the off-site sources air dispersion modeling.

[16] ARB, 2006.

Table 1. Source Parameters for Dispersion Modeling

Source	Source Type	Release Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp. (K)	Source Width (m)	Initial Vertical Dimension σ_z (m) [1]
CMF On-Site Sources							
Locomotives Idling [2]	Point	4.6	0.666	3.73	351	n/a	n/a
Locomotives Idling at Notch 8 [2,3]	Point	4.6	0.666	26.89	661	n/a	n/a
Locomotives Brake Test [2,4]	Point	4.6	0.666	11.38	530	n/a	n/a
Locomotives Brake Test at Notch 8 [2,3]	Point	4.6	0.666	26.89	661	n/a	n/a
Locomotives Load Testing [2,4]	Point	4.6	0.666	16.98	573	n/a	n/a
Locomotives on Moving Trains – Day [5,6]	Line	12.2	n/a	n/a	n/a	9.0	5.66
Locomotives on Moving Trains – Night [5,6]	Line	23.2	n/a	n/a	n/a	9.0	10.77
Locomotives Performing Switching – Day [5,7]	Area [8]	10.2	n/a	n/a	n/a	n/a	4.72
Locomotives Performing Switching – Night [5,7]	Area [8]	21.3	n/a	n/a	n/a	n/a	9.89
HEP Engines on Stationary Trains [9]	Point	4.6	0.144	39.54	591	n/a	n/a
HEP Engines Load Test [9]	Point	4.6	0.144	62.91	695	n/a	n/a
HEP Engines on Moving Trains – Day [5,10]	Line	8.3	n/a	n/a	n/a	9.0	3.87
HEP Engines on Moving Trains – Night [5,10]	Line	20.0	n/a	n/a	n/a	9.0	9.32
Emergency Generator No. 1 [11,12]	Point	2.2	0.095	75.3	823	n/a	n/a
Emergency Generator No. 2 [13,12]	Point	2.1	0.146	89.9	800	n/a	n/a
Forklifts and Welder [14]	Area [8]	4.2	n/a	n/a	n/a	n/a	1.93
Diesel Rail Car Mover – Day [5,15]	Area [8]	3.5	n/a	n/a	n/a	n/a	1.65
Diesel Rail Car Mover – Night [5,15]	Area [8]	6.3	n/a	n/a	n/a	n/a	2.93
Fuel and Delivery Trucks [14,16]	Line	4.2	n/a	n/a	n/a	10.0	1.93
Off-Site Sources							
Freight Trains on Mainline – Day [17,18]	Line	5.6	n/a	n/a	n/a	9.0	2.60
Freight Trains on Mainline - Night [17,18]	Line	14.6	n/a	n/a	n/a	9.0	6.77
Passenger Trains on Mainline – Day [5,19]	Line	4.8	n/a	n/a	n/a	9.0	2.25
Passenger Trains on Mainline - Night [5,19]	Line	18.4	n/a	n/a	n/a	9.0	8.54
On-Road Trucks [14,16]	Line	4.2	n/a	n/a	n/a	variable	1.93
Stationary Facilities [20]	Volume	3.0	n/a	n/a	n/a	10.0	1.42

Notes:

1. Consistent with the *Roseville Rail Yard Study*, the initial vertical dimension (σ_z) represents the source release height divided by a standard deviation of 2.15.
2. Stationary locomotives will be modeled as point sources. The source parameters by throttle notch setting were obtained from the *Roseville Rail Yard Study* (CARB, October 14, 2004) for the engine type (EMD 16-645E3B) most representative of the Metrolink CMF fleet.
3. Metrolink has one locomotive in its current fleet (F40PH) that has no separate HEP engine. The main engine must run at Notch 8 when providing HEP power.
4. The values for exit velocity and exit temperature for the brake test and load test were averaged using time-in-notch duty cycles provided by Metrolink.
5. Release height equals a locomotive stack height of 4.6 meters (for the locomotive main engine or HEP engine) or 3.5 meters (for the diesel railcar mover) plus the plume rise calculated by the U.S. EPA SCREEN3 screening-level dispersion model. SCREEN3 was run with urban dispersion parameters, a stack diameter of 0.666 meters for locomotive main engines, 0.144 meters for HEP engines, or 0.12 meters for the diesel railcar mover, and the following locomotive/railcar dimensions to simulate downwash effects: height of 4.57 meters, minimum horizontal dimension of 3.0 meters, and maximum horizontal dimension of 20 meters. Daytime conditions were represented in SCREEN3 with Stability D (most stable) and an average ambient air temperature of 294 K. Nighttime conditions were represented with Stability F (most stable) and an average ambient air temperature of 288 K.
6. Plume rise for locomotives on moving trains at the CMF was calculated with the following additional SCREEN3 stack parameters: exit velocity of 6.18 m/s, exit temperature of 413 K, an average daytime wind speed of 2.8 m/s, and an average nighttime travel/wind speed of 2.24 m/s.
7. Plume rise for locomotives performing switching at the CMF was calculated with the following additional SCREEN3 stack parameters: exit velocity of 5.42 m/s, exit temperature of 399 K, an average daytime wind speed of 2.8 m/s, and an average nighttime travel/wind speed of 2.24 m/s.
8. Area sources will cover the approximate area in which source emissions regularly occur.
9. Stack parameters for the HEP engines were provided by Metrolink and Caterpillar (Gen Set Package Performance Data. Models 3406CDITA and C27. Provided by Jessica Lamboo. March 25, 2014). Stack parameters were interpolated from the average engine power while on trains and during load tests.

Notes for Table 1, continued:

10. Plume rise for HEPs on moving trains at the CMF was calculated with the following additional SCREEN3 stack parameters: exit velocity of 39.54 m/s, exit temperature of 591 K, an average daytime wind speed of 2.8 m/s, and an average nighttime travel/wind speed of 2.24 m/s.
11. Release height and stack diameter were provided by Metrolink. Temperature and flow rate (used to derive exit velocity) were provided by Cummins Engine Company (6BTA5.9-G2 Advantage Data Sheet, June 19, 2000).
12. Because the emergency generators have rain caps, they will be modeled in AERMOD using the raincap beta option. The stack parameters in this table are prior to any adjustments made by AERMOD to account for the effects of the raincap.
13. Release height and stack diameter were provided by Metrolink. Temperature and flow rate (used to derive exit velocity) were provided by Cummins Power Generation (S-1146i Data Sheet, June 2006).
14. Consistent with the CARB Rail Yard HRAs (CARB 2007), on-road trucks and diesel yard equipment will be modeled using the release height and vertical dispersion parameter (σ_z) from the CARB *Diesel Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles*. (October, 2000), Appendix VII, Table 2.
15. Plume rise for the diesel railcar mover performing switching at the CMF was calculated with the following additional SCREEN3 stack parameters: exit velocity of 9.84 m/s, exit temperature of 811 K, an average daytime wind speed of 2.8 m/s, and an average nighttime travel/wind speed of 2.24 m/s.
16. For on-road vehicles, the line source width represents the width of the travelled way plus a 3-meter mixing zone width on either side. The width will vary off-site depending on the roadway being modeled.
17. Source parameters for freight train movement were obtained from the *Roseville Rail Yard Study*, Table G-1 (notch 2). Separate source parameters are provided for daytime (6am-6pm) and nighttime (6pm-6am) meteorological conditions.
18. The line source width of 9.0 meters represents the locomotive width (approximately 3 meters) plus a 3-meter mixing zone width on either side.
19. Plume rise for off-site passenger trains was calculated with the following additional SCREEN3 stack parameters: exit velocity of 13.3 m/s, exit temperature of 556 K, a daytime wind speed of 20 m/s (the maximum allowed by SCREEN3 with Stability D) and a nighttime wind speed of 4.0 m/s (the maximum allowed by SCREEN3 with Stability F). The plume rise at an average travel/wind speed of 50 mph (22.35 m/s) was adjusted by assuming the plume rise is proportional to (1/WS)^(1/3).
20. Stationary facilities will be conservatively modeled with relatively small dimensions to produce a concentrated plume. Per AERMOD guidance (*User's Guide for the AMD/EPA Regulatory Model – AERMOD*, U.S. EPA, September 2004), the source width of 10 meters will be divided by 4.3 to obtain the sigma y (σ_y) value.

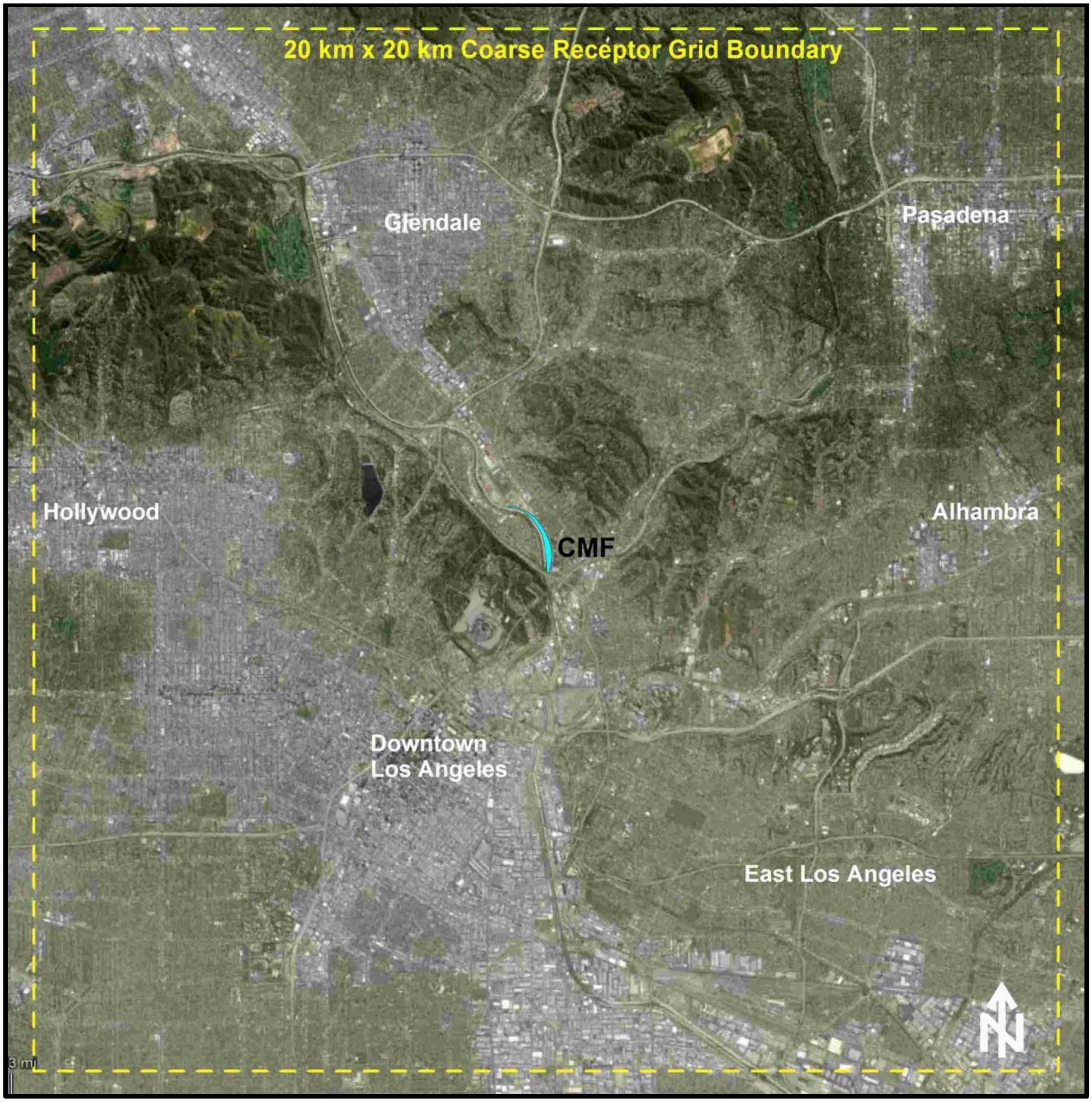


Figure 3. Receptor Domain

Health Risk Calculations

CEC will use the CARB's Hotspots Analysis and Reporting Program (HARP) to calculate health risks associated with CMF on-site diesel particulate matter (DPM) emissions. The Tier 1 HRA evaluation methodology, as described in OEHHA's *Air Toxics Hot Spots Program Risk Assessment Guidelines*, will be used. Individual lifetime cancer risks and chronic non-cancer hazard indices will be determined for the 2010, 2012, 2014, and 2017 operating conditions. [17] Results will be reported individually for each operating condition. The human breathing rates assumed for each receptor type will be consistent with the CARB rail yard HRAs and OEHHA guidelines. The reported HRA results will include the following:

- Cancer risk at the point of maximum impact (PMI) – this is defined as the highest predicted cancer risk (assuming 70-year residential exposure parameters) at any location outside the CMF, regardless of whether the location is occupied.

- Cancer risk at the maximum exposed individual resident (MEIR) – this is the greatest cancer risk (assuming 70-year and 30-year residential exposure parameters) in a zoned residential area.

- Cancer risk at the maximum exposed individual worker (MEIW) – this is the greatest cancer risk (assuming 40-year occupational exposure parameters) in a zoned industrial, commercial, or residential area outside the CMF.

- Cancer risk at all modeled sensitive receptors (assuming 70-year and 30-year residential, 40-year occupational, and/or 9-year school age child exposure parameters, as appropriate).

- Chronic non-cancer hazard indices at the point of maximum impact, maximum residential receptor, maximum occupational receptor, and at all modeled sensitive receptors.

In addition, isopleths (i.e., contour lines) of 70-year residential cancer risk will be generated over an aerial photo of the CMF and vicinity. CEC will use census tract data to estimate the human population and number of sensitive receptors exposed to specific ranges of residential cancer risk. The ranges will include 10-25 per million, 26-50 per million, 51-100 per million, 101-250 per million, 251-500 per million, and >500 per million. Predicted cancer risk results will also be

[17] Due to the uncertainties in the toxicological and epidemiological studies, diesel PM as a whole was not assigned a short-term acute REL. Only the specific compounds of diesel exhaust (e.g., acrolein) that independently have potential acute effects (such as irritation of the eyes and respiratory tract), have assigned acute RELs. However, acrolein is a chemically reactive and unstable compound, and easily reacts with a variety of chemical compounds in the atmosphere. Compared to the other compounds in diesel exhaust, the concentration of acrolein has a much lower chance of reaching a distant off-site receptor. More importantly, given the multitude of activities ongoing at facilities as complex as railyards, there is a much higher level of uncertainty associated with maximum hourly-specific emission data, which are essential for assessing acute risk (ARB 2007). Therefore, similar to the ARB rail yard HRAs, non-cancer acute risk will not be addressed quantitatively in the CMF HRA. From a risk management perspective, ARB staff believes it is reasonable to focus on diesel PM cancer risk because it is the predominant risk driver, and the most effective parameter to evaluate risk reduction actions. Moreover, actions to reduce diesel PM will also reduce non-cancer risks resulting from acute exposure (CARB 2007).

compared to the background cancer risk for the region as estimated in the most recent version of the AQMD's *MATES* report.

For the evaluation of risks associated with off-site emission sources, the same risk assessment approach described above for the CMF will be used, and the same categories of risk results will be reported.

Report Preparation

CEC will prepare draft and final reports documenting the methodology and results of the CMF baseline emissions assessment and HRA. The report will be similar to the CARB rail yard HRA reports in terms of content, level of detail, and types of tables and figures. Relevant appendices detailing the analysis methodology will be included in the report.

Appendix B

Diesel PM Emission Calculation Tables for the CMF

List of Tables

List of Tables (continued)

Table B-1. Metrolink Locomotive Descriptions

Loco Model	Year In Service	Engine Model	Emission Tier	Power Cycle	Engine Size (hp)	HEP Engine-Equipped
F59PH	1992	EMD 12-710G3A	Pre-Tier 0	2-stroke	3,000	Yes
F59PHI	1995-2001	EMD 12N-710G3C-EC	Pre-Tier 0	2-stroke	3,000	Yes
F40PH	1985	EMD 16-645E3	Pre-Tier 0	2-stroke	3,000	No
MP36PH-3C	2008	EMD EFI 16-645F3B-T2R	Tier 2	2-stroke	3,600	Yes
59PH Repowered	2010	EMD 12-710G3B-T2	Tier 2	2-stroke	3,000	Yes
F125	2015-2017	C175-20 (with SCR)	Tier 4	4-stroke	4,700	No

Notes:

1. Locomotive descriptions were provided by Metrolink.

Table B-2. Metrolink Locomotive Fleet Population

Loco Model	No. of Locomotives				AESS Equipped				HEP Engines			
	2010	2012	2014	2017	2010	2012	2014	2017	2010	2012	2014	2017
F59PH	15	15	15	5	0	0	0	0	14 Cat 3406, 1 Cat C27	14 Cat 3406, 1 Cat C27	14 Cat 3406, 1 Cat C27	5 Cat C27
F59PHI	14	14	14	5	11	11	11	5	4 Cat 3412, 10 Cat C27	4 Cat 3412, 10 Cat C27	4 Cat 3412, 10 Cat C27	5 Cat C27
F40PH	1	1	1	0	0	0	0	0	0	0	0	0
MP36PH-3C	15	15	15	15	15	15	15	15	15 Cat C27	15 Cat C27	15 Cat C27	15 Cat C27
59PH Repowered	7	7	7	7	7	7	7	7	7 Cat C27	7 Cat C27	7 Cat C27	7 Cat C27
F125	0	0	0	20	0	0	0	20	0	0	0	0
Total	**52**	**52**	**52**	**52**	**33**	**33**	**33**	**47**				

Notes:

1. F40PH and F125 locomotives have no separate HEP engines.
2. The locomotive and HEP engine fleets are assumed to be the same for 2010, 2012, and 2014.
3. In 2017, 20 F125 Tier 4 locomotives will replace 10 F59PH, 9 F59PHI, and 1 F40PH locomotives.

Table B-3. Locomotive Usage Allocation at the CMF

Loco Model	Percent of Usage				Percent AESS Equipped				Percent HEP Equipped			
	2010	2012	2014	2017	2010	2012	2014	2017	2010	2012	2014	2017
F59PH	29%	29%	29%	8%	0%	0%	0%	0%	100%	100%	100%	100%
F59PHI	27%	27%	27%	8%	79%	79%	79%	100%	100%	100%	100%	100%
F40PH	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MP36PH-3C	29%	29%	29%	25%	100%	100%	100%	100%	100%	100%	100%	100%
59PH Repowered	14%	14%	14%	12%	100%	100%	100%	100%	100%	100%	100%	100%
F125	0%	0%	0%	46%	0%	0%	0%	100%	0%	0%	0%	0%
Total	**100%**	**100%**	**100%**	**100%**	**64%**	**64%**	**64%**	**92%**	**99%**	**99%**	**99%**	**54%**

Notes:

1. Locomotive model usage at CMF in 2010, 2012, and 2014 is assumed to be proportional to the system-wide locomotive fleet mix.
2. Locomotive model usage at CMF in 2017 will be a minimum of 12 F125 Tier 4 locomotives out of 26 trains (46%); the remaining locomotive model usage is assumed to be proportional to the system-wide Non-Tier 4 fleet mix.
3. Fleet percentages are adjusted to account for the F40PH locomotive being used 75 percent as much as other locomotives.

Table B-4. Metrolink HEP Engine Fleet Description

Engine Model	In Service	Emission Tier	Engine Size (hp)	Fleet Population 2010	2012	2014	2017
Cat 3406	1992	Unclassified	536	14	14	14	0
Cat 3412	2001	Tier 1	536	4	4	4	0
Cat C27	2006	Tier 2	976	33	33	33	32
Total				**51**	**51**	**51**	**32**

Notes:

1. HEP engine descriptions were provided by Metrolink.

Table B-5. Summary of Annual Locomotive and HEP Engine Activity during Train Operation at CMF

Analysis Year	Annual No. of Trains at CMF	Average Run Time for HEP Engines (min/train)	Average Ground Power Plug-In Time per Train (min/train) [1]	Work Done by HEP Engines (excluding locos without HEP engine) (bhp-hr/yr) [5]	Average Time for Train Movements (min/train)	Average Time for Air Brake Test (Excluding Idle) (min/train) [2]	Average Locomotive Idling Time (min/train) [3,4]
2010	8,239	285	0	6,029,466	31	11	288
2012	8,239	96	31	2,071,783	31	11	160
2014	6,935	86	48	1,551,173	29	11	153
2017	6,935	86	48	847,530	29	11	153

Notes:

1. Average Ground Power Plug-In Time was provided by Metrolink. Total minutes = 4825 min/week for 2012; and 6350 min/week for 2014 & 2017.
2. Locomotive main engine runtime for the air brake test is based on actual data collected by Metrolink during 6 representative air brake tests.
3. Locomotives without a separate HEP engine (F40PH and F125) run at higher than Idle in some cases when also producing railcar auxiliary power.
4. Idling times are conservative because they don't take credit for reduced idling on AESS-equipped locomotives. Locomotives are assumed to run or idle continuously while at the CMF in 2010. In 2012, idling times were allocated as follows: approx. 15 minutes from arrival to S&I tracks, approx. 100 minutes during fueling, inspection, and testing; approx. 15 minutes during repositioning to storage; and approx. 30 minutes prior to departure for warmup and mandatory testing. Idling times in 2014 and 2017 are slightly less due to less repositioning due to fewer trains.
5. HEP usage in 2012-2017 was adjusted upward to account for 4 percent of trains arriving on the River Track with the HEP engine running. HEP runtime during train arrival was assumed to be 20 minutes, which is the average time from CMF entry to Service & Inspection track. In 2010, HEP engines were assumed to run continuously while at the CMF so no further adjustment was necessary. The reduction in HEP engine use in 2017 occurs because the 20 F125 Tier 4 locomotives will not have a HEP engine. All auxiliary power will be supplied by the prime mover.
6. All usage data in this table were derived from data provided by Metrolink.

Table B-6. HEP Engine Usage During Train Operation at the CMF

Engine Model	Annual Usage (bhp-hr/yr)			
	2010	2012	2014	2017
Cat 3406	1,655,147	568,725	425,812	0
Cat 3412	472,899	162,493	121,661	0
Cat C27	3,901,419	1,340,566	1,003,700	847,530
Total	**6,029,466**	**2,071,783**	**1,551,173**	**847,530**

Notes:

1. Usage is apportioned equally to all HEP engines in the fleet.

Table B-7. Summary of Additional Locomotive and HEP Engine Activity

Operation	No. of Days or Tests per Year			
	2010	2012	2014	2017
Locomotive switching 2nd Shift (6 hr/day) [1]	40	40	15	15
Main Engine Load Test (PM's and Repairs)	312	312	312	312
HEP Engine Load Test (PM's and Repairs) [2]	312	312	312	170

Notes:

1. Locomotive switching will be reduced to 10-15 days per year (conservatively assume 15) in 2014 and 2017 because the electric car mover will be used as the primary switcher, the diesel car mover will be used as first backup (assume 25 days per year x 6 hr/day = 150 hr/yr), and locomotive switching will be used as second backup.
2. HEP engine load tests in 2017 will be reduced in proportion to the HEP engine population at CMF.
3. Locomotive and HEP engine activity were provided by Metrolink.

Table B-8. Switching on 2nd Shift - Locomotive

Power Setting	Minutes
Time - Idle	180
Time - Notch 1	60
Time - Notch 2	60
Time - Notch 3	60
Totals	**360**

Note: Data provided by Metrolink.

Table B-9. Load Testing - Main Engine (PM's and Repairs)

Power Setting	Minutes
Time - Notch 1	5
Time - Notch 2	5
Time - Notch 3	5
Time - Notch 4	5
Time - Notch 5	5
Time - Notch 6	5
Time - Notch 7	5
Time - Notch 8	15
Totals	**50**

Note: Data provided by Metrolink.

Table B-10. Load Testing - HEP Engine (PM's and Repairs)

Power Setting	bhp	Minutes	bhp-hr
Time - 100kW	154	5	12.8
Time - 150kW	230	5	19.2
Time - 200kW	308	5	25.6
Time - 250kW	385	5	32.1
Time - 300kW	461	5	38.4
Time - 350kW	538	5	44.8
Totals	**346**	**30**	**173.0**

Note: bhp values were obtained from C27 performance data because they are more conservative than the 3406 data.

Table B-11. HEP Engine Usage during Load Tests at the CMF

Engine Model	Annual Usage (bhp-hr/yr)			
	2010	2012	2014	2017
Cat 3406	14,817	14,817	14,817	0
Cat 3412	4,233	4,233	4,233	0
Cat C27	34,926	34,926	34,926	29,491
Total	**53,976**	**53,976**	**53,976**	**29,491**

Notes:

1. Usage is apportioned equally to all HEP engines in the fleet.

Table B-12. Locomotive Main Engine Usage during Train Operation - 2010

Loco Model	Percent Usage	Fraction AESS-Equipped	HEP Engine-Equipped	Duration (hr/yr)					
				Idling while Locomotive is Producing Auxiliary Power	Idling while Locomotive is Not Producing Auxiliary Power	Brake Test while Locomotive is Producing Auxiliary Power	Brake Test while Locomotive is Not Producing Auxiliary Power	Moving while Locomotive is Producing Auxiliary Power	Moving while Locomotive is Not Producing Auxiliary Power
F59PH	29%	0%	TRUE	9,677	1,801	438	0	1,220	0
F59PHI	27%	79%	TRUE	9,031	1,681	409	0	1,138	0
F40PH	1%	0%	FALSE	484	90	22	0	61	0
MP36PH-3C	29%	100%	TRUE	9,677	1,801	438	0	1,220	0
59PH Repowered	14%	100%	TRUE	4,516	841	204	0	569	0
F125	0%	0%	FALSE	0	0	0	0	0	0
Total	**100%**			**33,384**	**6,215**	**1,510**	**0**	**4,208**	**0**

Table B-13. Locomotive Main Engine Usage during Train Operation - 2012

Loco Model	Percent Usage	Fraction AESS-Equipped	HEP Engine-Equipped	Duration (hr/yr)					
				Idling while Locomotive is Producing Auxiliary Power	Idling while Locomotive is Not Producing Auxiliary Power	Brake Test while Locomotive is Producing Auxiliary Power	Brake Test while Locomotive is Not Producing Auxiliary Power	Moving while Locomotive is Producing Auxiliary Power	Moving while Locomotive is Not Producing Auxiliary Power
F59PH	29%	0%	TRUE	3,354	2,996	268	169	207	1,013
F59PHI	27%	79%	TRUE	3,130	2,797	250	158	193	945
F40PH	1%	0%	FALSE	168	150	13	8	10	51
MP36PH-3C	29%	100%	TRUE	3,354	2,996	268	169	207	1,013
59PH Repowered	14%	100%	TRUE	1,565	1,398	125	79	97	473
F125	0%	0%	FALSE	0	0	0	0	0	0
Total	**100%**			**11,571**	**10,338**	**926**	**585**	**714**	**3,494**

Table B-14. Locomotive Main Engine Usage during Train Operation - 2014

Loco Model	Percent Usage	Fraction AESS-Equipped	HEP Engine-Equipped	Duration (hr/yr)					
				Idling while Locomotive is Producing Auxiliary Power	Idling while Locomotive is Not Producing Auxiliary Power	Brake Test while Locomotive is Producing Auxiliary Power	Brake Test while Locomotive is Not Producing Auxiliary Power	Moving while Locomotive is Producing Auxiliary Power	Moving while Locomotive is Not Producing Auxiliary Power
F59PH	29%	0%	TRUE	2,592	2,549	104	265	174	794
F59PHI	27%	79%	TRUE	2,419	2,379	97	247	163	741
F40PH	1%	0%	FALSE	130	127	5	13	9	40
MP36PH-3C	29%	100%	TRUE	2,592	2,549	104	265	174	794
59PH Repowered	14%	100%	TRUE	1,209	1,190	49	123	81	370
F125	0%	0%	FALSE	0	0	0	0	0	0
Total	**100%**			**8,942**	**8,796**	**359**	**913**	**601**	**2,738**

Table B-15. Locomotive Main Engine Usage during Train Operation - 2017

Loco Model	Percent Usage	Fraction AESS-Equipped	HEP Engine-Equipped	Duration (hr/yr)					
				Idling while Locomotive is Producing Auxiliary Power	Idling while Locomotive is Not Producing Auxiliary Power	Brake Test while Locomotive is Producing Auxiliary Power	Brake Test while Locomotive is Not Producing Auxiliary Power	Moving while Locomotive is Producing Auxiliary Power	Moving while Locomotive is Not Producing Auxiliary Power
F59PH	8%	0%	TRUE	752	740	30	77	51	230
F59PHI	8%	100%	TRUE	752	740	30	77	51	230
F40PH	0%	0%	FALSE	0	0	0	0	0	0
MP36PH-3C	25%	100%	TRUE	2,257	2,220	91	230	152	691
59PH Repowered	12%	100%	TRUE	1,053	1,036	42	108	71	322
F125	46%	100%	FALSE	4,127	4,060	166	421	277	1,264
Total	**100%**			**8,942**	**8,796**	**359**	**913**	**601**	**2,738**

Table B-16. Locomotive Main Engine Usage during Yard Switching

Loco Model	Annual Usage (hr/yr) 2010	2012	2014	2017
F59PH	98	98	37	26
F59PHI	91	91	34	26
F40PH	5	5	2	0
MP36PH-3C	0	0	0	0
59PH Repowered	46	46	17	37
F125	0	0	0	0
Total	**240**	**240**	**90**	**90**

Notes:

1. Yard switching is allocated to the "PH" locomotives in proportion to their population.

Table B-17. Locomotive Main Engine Usage during Load Testing

Loco Model	Annual Usage (hr/yr) 2010	2012	2014	2017
F59PH	75	75	75	25
F59PHI	70	70	70	25
F40PH	5	5	5	0
MP36PH-3C	75	75	75	75
59PH Repowered	35	35	35	35
F125	0	0	0	100
Total	**260**	**260**	**260**	**260**

Notes:

1. Load testing is allocated equally to all locomotives in proportion to their system-wide population.

Table B-18. Off-Road Diesel Equipment at CMF

Equipment Description	Year In Service	Engine Size (hp)	Usage (hr/yr) 2010	2012	2014	2017
Emergency Generator 1	1992	220	22	22	22	22
Emergency Generator 2	1992	535	25	25	25	25
5-ton Forklift	1992	100	120	120	120	120
1.5-ton Forklift	1992	45	120	120	120	120
Welder	2005	13	180	180	180	180
Diesel Rail Car Mover	2002	152	1,760	1,760	150	150

Notes:

1. In 2014 and 2017, the electric car mover will be used as the primary switcher (1,760 hr/yr), and the diesel car mover will be used as first backup (assume 25 days per year x 6 hr/day = 150 hr/yr). Locomotive switching will be used as second backup (assume 15 days/yr).

Table B-19. On-Road Diesel Vehicle Activity at CMF

Vehicle Description	Model or Size Category	Year In Service	2010		2012		2014		2017	
			On-Site Idling (hr/yr)	On-Site Driving (mi/yr)	On-Site Idling (hr/yr)	On-Site Driving (mi/yr)	On-Site Idling (hr/yr)	On-Site Driving (mi/yr)	On-Site Idling (hr/yr)	On-Site Driving (mi/yr)
Locomotive Fueling Truck	International 4900	1997	24	288	24	288	0	0	0	0
Fuel Delivery Truck	HHDDT	Fleet Avg	78	374	78	374	66	374	66	374
Vendor Deliveries	Various	Fleet Avg	22	624	22	624	22	624	22	624

Notes:

1. The locomotive fueling truck (International 4900) is used to fuel locomotives at remote Metrolink sites (outside the CMF). It will not be used in 2014 and 2017; outside services (not entering the CMF) will be used instead to fuel locomotives at remote sites.

Table B-20. Locomotive Duty Cycles used in the CMF HRA

Notch	Time in Notch														
	LHDC	CMFS	CMFL	CMFM	CMFMX	CMFMX	CMFB	CMFBX	CMFBX	CMFI	CMFIX	CMFIX	ML3	ML45	ML56
	EPA Line Haul	CMF Switching	CMF Load Test	CMF Train Moves - No Aux Power	CMF Train Moves and Aux Power - F125	CMF Train Moves and Aux Power - F40PH	CMF Brake Test - No Aux Power	CMF Brake Test and Aux Power - F125	CMF Brake Test and Aux Power - F40PH	CMF Idling - No Aux Power	CMF Idling and Aux Power - F125	CMF Idling and Aux Power - F40PH	Offsite N3	Offsite N4 & N5	Offsite N5 & N6
Idle	38.0%	50.0%		47.0%						100.0%					
DB	12.5%														
1	6.5%	16.7%	10.0%	13.6%	60.6%		2.0%	2.0%			100.0%				
2	6.5%	16.7%	10.0%	20.1%	20.1%		0.2%	0.2%							
3	5.2%	16.7%	10.0%	7.0%	7.0%		39.7%	39.7%					100.0%		
4	4.4%		10.0%	5.1%	5.1%		45.3%	45.3%						50.0%	
5	3.8%		10.0%	7.0%	7.0%		12.9%	12.9%						50.0%	50.0%
6	3.9%		10.0%	0.3%	0.3%										50.0%
7	3.0%		10.0%												
8	16.2%		30.0%			100.0%			100.0%			100.0%			
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Notes:

1. The CMF duty cycles were provided by Metrolink and ElectroMotive (5/30/2014).
2. The duty cycles for brake test exclude idling time.
3. The F125 and F40PH locomotives do not have separate HEP engines. Therefore, the main engine must run at higher notch settings in some cases while producing auxiliary power to the railcars.
4. The EPA line haul duty cycle (LHDC) is from U.S. EPA. *Locomotive Emission Standards. Regulatory Support Document* . April 1998.

Table B-21. Locomotive Emission Test Data - F59PH - Non-CA Diesel Fuel - 3000 ppm Fuel Sulfur Content

Notch	Power in Notch (bhp)	Fuel Rate (lb/hr)	BSFC (lb/bhp-hr)	PM Emission Factor	
				g/hr	g/bhp-hr
Idle	8.0	19.0	2.38	31.0	3.88
DB	64.3	142.0	2.21	50.0	0.78
1	209.0	91.0	0.44	35.0	0.17
2	372.0	141.0	0.38	115.0	0.31
3	717.0	258.0	0.36	213.0	0.30
4	1,053.0	372.0	0.35	238.0	0.23
5	1,402.0	491.0	0.35	296.0	0.21
6	1,696.0	587.0	0.35	420.0	0.25
7	2,534.0	848.0	0.33	541.0	0.21
8	3,196.0	1,077.0	0.34	748.0	0.23
LHDC	845.7	311.3	0.37	214.4	0.25

Notes:

1. Source for emission factors: U.S. EPA. Locomotive Emission Standards. Regulatory Support Document. April 1998. Appendix B (provided in electronic format from C. Moulis to J. Castleberry, 4/3/2013). EMD 12-710G3A.
2. LHDC = EPA line haul locomotive duty cycle.
3. Source for fuel sulfur content: USEPA (2008). Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder. EPA420-R-08-001a. May.

Table B-22. Locomotive Emission Factors for the CMF HRA - F59PH

Notch / Duty Cycle	Power in Notch (bhp)	Fuel Rate (lb/hr)	BSFC (lb/bhp-hr)	DPM Emission Factor g/hr	DPM Emission Factor g/bhp-hr
Idle	8	19	2.38	35.7	4.46
DB	64	142	2.21	57.5	0.89
1	209	91	0.44	40.3	0.19
2	372	141	0.38	132.3	0.36
3	717	258	0.36	228.2	0.32
4	1,053	372	0.35	239.7	0.23
5	1,402	491	0.35	290.0	0.21
6	1,696	587	0.35	423.5	0.25
7	2,534	848	0.33	565.2	0.22
8	3,196	1,077	0.34	779.9	0.24
LHDC	846	311	0.37	225.2	0.27
CMFS	220	91	0.41	84.6	0.38
CMFL	1,757	602	0.34	425.9	0.24
CMFM	313	123	0.39	98.4	0.31
CMFMX	313	123	0.39	98.4	0.31
CMFB	947	336	0.36	237.5	0.25
CMFBX	947	336	0.36	237.5	0.25
CMFI	8	19	2.38	35.7	4.46
CMFIX	8	19	2.38	35.7	4.46
ML3	717	258	0.36	228.2	0.32
ML45	1,228	432	0.35	264.8	0.22
ML56	1,549	539	0.35	356.7	0.23

Notes:

1. A deterioration factor of 1.15 was applied to PM emissions (EPA 1998, Appendix B).
2. PM emissions were adjusted to account for a 15 ppm sulfur content of CARB diesel fuel using CARB methodology (ARB. 2005a. OFFROAD Modeling Change Technical Memo, "Changes to the Locomotive Inventory," prepared by Walter Wong, preliminary draft. March 16, 2005. Available online March 31, 2006: http://www.arb.ca.gov/msei/on-road/downloads/docs/Locomotive_Memo.pdf).
3. LHDC = EPA line haul locomotive duty cycle; CMFS = CMF switching duty cycle; CMFL = CMF load test duty cycle; CMFM = CMF train movement duty cycle while loco is not producing aux power; CMFMX = CMF train movement duty cycle while loco is producing aux power; CMFB = CMF brake test duty cycle while loco is not producing aux power; CMFBX = CMF brake test duty cycle while loco is producing aux power; CMFI = CMF idling duty cycle while loco is not producing aux power; CMFIX = CMF idling duty cycle while loco is producing aux power; ML3 = traveling on mainline at Notch 3; ML45 = traveling on mainline at Notches 4 and 5; ML56 = traveling on mainline at Notches 5 and 6.

Table B-23. Locomotive Emission Test Data - F59PHI - CARB Diesel Fuel - 40 ppm Fuel Sulfur Content

Notch	Power in Notch (bhp)	Fuel Rate (lb/hr)	BSFC (lb/bhp-hr)	PM Emission Factor	
				g/hr	g/bhp-hr
Idle	10.5	24.2	2.30	17.0	1.62
DB	10.5	24.2	2.30	17.0	1.62
1	199.8	81.7	0.41	33.0	0.17
2	365.0	140.0	0.38	57.3	0.16
3	702.9	253.3	0.36	140.0	0.20
4	1,039.6	366.8	0.35	249.0	0.24
5	1,378.6	478.8	0.35	363.7	0.26
6	1,697.0	581.6	0.34	486.7	0.29
7	2,532.0	840.8	0.33	852.3	0.34
8	3,144.0	1,056.5	0.34	1,075.3	0.34
LHDC	828.2	293.2	0.35	265.3	0.32

Notes:

1. Source for emission factors and fuel sulfur content: Emissions test on SCAX 874 conducted in 1996. (SwRI, personal communication from S. Fritz to J. Castleberry, 4/5/2013).
2. LHDC = EPA line haul locomotive duty cycle.

Table B-24. Locomotive Emission Factors for the CMF HRA - F59PHI

Notch / Duty Cycle	Power in Notch (bhp)	Fuel Rate (lb/hr)	BSFC (lb/bhp-hr)	DPM Emission Factor g/hr	DPM Emission Factor g/bhp-hr
Idle	11	24	2.30	19.6	1.86
DB	11	24	2.30	19.6	1.86
1	200	82	0.41	38.0	0.19
2	365	140	0.38	65.9	0.18
3	703	253	0.36	160.9	0.23
4	1,040	367	0.35	286.0	0.28
5	1,379	479	0.35	417.6	0.30
6	1,697	582	0.34	559.0	0.33
7	2,532	841	0.33	979.4	0.39
8	3,144	1,056	0.34	1,235.6	0.39
LHDC	828	293	0.35	304.8	0.37
CMFS	217	91	0.42	53.9	0.25
CMFL	1,735	591	0.34	621.3	0.36
CMFM	309	122	0.40	84.2	0.27
CMFMX	309	122	0.40	84.2	0.27
CMFB	932	330	0.35	248.0	0.27
CMFBX	932	330	0.35	248.0	0.27
CMFI	11	24	2.30	19.6	1.86
CMFIX	11	24	2.30	19.6	1.86
ML3	703	253	0.36	160.9	0.23
ML45	1,209	423	0.35	351.8	0.29
ML56	1,538	530	0.34	488.3	0.32

Notes:

1. A deterioration factor of 1.15 was applied to PM emissions (EPA 1998, Appendix B).
2. PM emissions were adjusted to account for a 15 ppm sulfur content of CARB diesel fuel using CARB methodology (ARB. 2005a. OFFROAD Modeling Change Technical Memo, "Changes to the Locomotive Inventory," prepared by Walter Wong, preliminary draft. March 16, 2005. Available online March 31, 2006: http://www.arb.ca.gov/msei/on-road/downloads/docs/Locomotive_Memo.pdf).
3. LHDC = EPA line haul locomotive duty cycle; CMFS = CMF switching duty cycle; CMFL = CMF load test duty cycle; CMFM = CMF train movement duty cycle while loco is not producing aux power; CMFMX = CMF train movement duty cycle while loco is producing aux power; CMFB = CMF brake test duty cycle while loco is not producing aux power; CMFBX = CMF brake test duty cycle while loco is producing aux power; CMFI = CMF idling duty cycle while loco is not producing aux power; CMFIX = CMF idling duty cycle while loco is producing aux power; ML3 = traveling on mainline at Notch 3; ML45 = traveling on mainline at Notches 4 and 5; ML56 = traveling on mainline at Notches 5 and 6.

Table B-25. Locomotive Emission Test Data - F40PH - Non-CA Diesel Fuel - 3000 ppm Fuel Sulfur Content

Notch	Power in Notch (bhp)	Fuel Rate (lb/hr)	BSFC (lb/bhp-hr)	PM Emission Factor	
				g/hr	g/bhp-hr
Idle	17.0	40.0	2.35	47.9	2.82
DB	69.0	114.0	1.65	80.0	1.16
1	105.0	64.0	0.61	36.0	0.34
2	395.0	167.0	0.42	133.0	0.34
3	686.0	275.0	0.40	226.0	0.33
4	1,034.0	404.0	0.39	258.0	0.25
5	1,461.0	556.0	0.38	336.0	0.23
6	1,971.0	740.0	0.38	544.0	0.28
7	2,661.0	994.0	0.37	648.0	0.24
8	3,159.0	1,177.0	0.37	837.0	0.26
LHDC	852.7	347.0	0.41	251.3	0.29

Notes:

1. Source for emission factors: U.S. EPA. Locomotive Emission Standards. Regulatory Support Document. April 1998. Appendix B (provided in electronic format from C. Moulis to J. Castleberry, 4/3/2013). EMD 16-645E3.
2. LHDC = EPA line haul locomotive duty cycle.
3. Source for fuel sulfur content: USEPA (2008). Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder. EPA420-R-08-001a. May.

Table B-26. Locomotive Emission Factors for the CMF HRA - F40PH

Notch / Duty Cycle	Power in Notch (bhp)	Fuel Rate (lb/hr)	BSFC (lb/bhp-hr)	DPM Emission Factor g/hr	DPM Emission Factor g/bhp-hr
Idle	17	40	2.35	55.1	3.24
DB	69	114	1.65	92.0	1.33
1	105	64	0.61	41.4	0.39
2	395	167	0.42	153.0	0.39
3	686	275	0.40	242.1	0.35
4	1,034	404	0.39	259.8	0.25
5	1,461	556	0.38	329.1	0.23
6	1,971	740	0.38	548.5	0.28
7	2,661	994	0.37	676.9	0.25
8	3,159	1,177	0.37	872.7	0.28
LHDC	853	347	0.41	264.7	0.31
CMFS	206	104	0.51	100.3	0.49
CMFL	1,779	673	0.38	486.9	0.27
CMFM	310	142	0.46	116.9	0.38
CMFMX	3,159	1,177	0.37	872.7	0.28
CMFB	931	365	0.39	257.2	0.28
CMFBX	3,159	1,177	0.37	872.7	0.28
CMFI	17	40	2.35	55.1	3.24
CMFIX	3,159	1,177	0.37	872.7	0.28
ML3	3,159	1,177	0.37	872.7	0.28
ML45	3,159	1,177	0.37	872.7	0.28
ML56	3,159	1,177	0.37	872.7	0.28

Notes:

1. A deterioration factor of 1.15 was applied to PM emissions (EPA 1998, Appendix B).
2. PM emissions were adjusted to account for a 15 ppm sulfur content of CARB diesel fuel using CARB methodology (ARB. 2005a. OFFROAD Modeling Change Technical Memo, "Changes to the Locomotive Inventory," prepared by Walter Wong, preliminary draft. March 16, 2005. Available online March 31, 2006: http://www.arb.ca.gov/msei/on-road/downloads/docs/Locomotive_Memo.pdf).
3. LHDC = EPA line haul locomotive duty cycle; CMFS = CMF switching duty cycle; CMFL = CMF load test duty cycle; CMFM = CMF train movement duty cycle while loco is not producing aux power; CMFMX = CMF train movement duty cycle while loco is producing aux power; CMFB = CMF brake test duty cycle while loco is not producing aux power; CMFBX = CMF brake test duty cycle while loco is producing aux power; CMFI = CMF idling duty cycle while loco is not producing aux power; CMFIX = CMF idling duty cycle while loco is producing aux power; ML3 = traveling on mainline at Notch 3; ML45 = traveling on mainline at Notches 4 and 5; ML56 = traveling on mainline at Notches 5 and 6.

Table B-27. Locomotive Emission Test Data - MP36PH-3C - Non-CA Diesel Fuel - 500 ppm Fuel Sulfur Content

Notch	Power in Notch (bhp)	Fuel Rate (lb/hr)	BSFC (lb/bhp-hr)	PM Emission Factor	
				g/hr	g/bhp-hr
Idle	23.2	23.7	1.02	3.0	0.13
DB	91.8	111.9	1.22	35.8	0.39
1	201.7	92.6	0.46	20.8	0.10
2	469.9	188.9	0.40	55.3	0.12
3	860.7	330.8	0.38	84.0	0.10
4	1,087.0	421.1	0.39	141.9	0.13
5	1,599.6	603.2	0.38	243.5	0.15
6	2,260.2	836.7	0.37	386.3	0.17
7	3,153.4	1,158.8	0.37	390.5	0.12
8	3,719.8	1,394.2	0.37	450.7	0.12
LHDC	1,002.7	393.2	0.39	130.2	0.13

Notes:

1. Source: Emissions test on SCAX 893 conducted 5/12/2008. (Wabtec, personal communication from S. Shakenis to J. Castleberry, 4/5/2013).
2. LHDC = EPA line haul locomotive duty cycle.
3. Source for fuel sulfur content: USEPA (2008). Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder. EPA420-R-08-001a. May.

Table B-28. Locomotive Emission Factors for the CMF HRA - MP36PH-3C

Notch / Duty Cycle	Power in Notch (bhp)	Fuel Rate (lb/hr)	BSFC (lb/bhp-hr)	DPM Emission Factor	
				g/hr	g/bhp-hr
Idle	23	24	1.02	3.5	0.15
DB	92	112	1.22	41.1	0.45
1	202	93	0.46	23.9	0.12
2	470	189	0.40	63.6	0.14
3	861	331	0.38	95.4	0.11
4	1,087	421	0.39	159.5	0.15
5	1,600	603	0.38	272.3	0.17
6	2,260	837	0.37	434.3	0.19
7	3,153	1,159	0.37	441.9	0.14
8	3,720	1,394	0.37	509.7	0.14
LHDC	1,003	393	0.39	147.2	0.15
CMFS	267	114	0.43	32.2	0.12
CMFL	2,079	781	0.38	302.0	0.15
CMFM	366	151	0.41	52.7	0.14
CMFMX	366	151	0.41	52.7	0.14
CMFB	1,045	402	0.38	145.8	0.14
CMFBX	1,045	402	0.38	145.8	0.14
CMFI	23	24	1.02	3.5	0.15
CMFIX	23	24	1.02	3.5	0.15
ML3	861	331	0.38	95.4	0.11
ML45	1,343	512	0.38	215.9	0.16
ML56	1,930	720	0.37	353.3	0.18

Notes:

1. A deterioration factor of 1.15 was applied to PM emissions (EPA 1998, Appendix B).
2. PM emissions were adjusted to account for a 15 ppm sulfur content of CARB diesel fuel using CARB methodology (ARB. 2005a. OFFROAD Modeling Change Technical Memo, "Changes to the Locomotive Inventory," prepared by Walter Wong, preliminary draft. March 16, 2005. Available online March 31, 2006: http://www.arb.ca.gov/msei/on-road/downloads/docs/Locomotive_Memo.pdf).
3. LHDC = EPA line haul locomotive duty cycle; CMFS = CMF switching duty cycle; CMFL = CMF load test duty cycle; CMFM = CMF train movement duty cycle while loco is not producing aux power; CMFMX = CMF train movement duty cycle while loco is producing aux power; CMFB = CMF brake test duty cycle while loco is not producing aux power; CMFBX = CMF brake test duty cycle while loco is producing aux power; CMFI = CMF idling duty cycle while loco is not producing aux power; CMFIX = CMF idling duty cycle while loco is producing aux power; ML3 = traveling on mainline at Notch 3; ML45 = traveling on mainline at Notches 4 and 5; ML56 = traveling on mainline at Notches 5 and 6.

Table B-29. Locomotive Emission Test Data - 59PH Repowered - Non-CA Diesel Fuel - 500 ppm Fuel Sulfur Content

Notch	Power in	Fuel Rate	BSFC (lb/bhp-	PM Emission	
				g/hr	g/bhp-hr
Idle	10.5	24.2	2.30	7.6	0.72
DB	10.5	24.2	2.30	7.6	0.72
1	199.8	81.7	0.41	14.7	0.07
2	365.0	140.0	0.38	25.5	0.07
3	702.9	253.3	0.36	63.1	0.09
4	1,039.6	366.8	0.35	113.4	0.11
5	1,378.6	478.8	0.35	166.4	0.12
6	1,697.0	581.6	0.34	221.5	0.13
7	2,532.0	840.8	0.33	385.6	0.15
8	3,144.0	1,056.5	0.34	486.7	0.15
LHDC	828.2	293.2	0.35	120.1	0.15

Notes:

1. Source: EPA Certification data for EMD 710G-T2, years 2008-2010. Website: http://www.epa.gov/otaq/certdata.htm#locomotive. Notch-specific emission factors are assumed to have the same relative proportion as engine EMD 12N-710G3C-EC (F59PHI) since this Pre-Tier 0 engine is a more recent model year than EMD 12-710G3A (F59PH). Website accessed 4/3/2013.
2. LHDC = EPA line haul locomotive duty cycle.
3. Source for fuel sulfur content: USEPA (2008). Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder. EPA420-R-08-001a. May.

Table B-30. Locomotive Emission Factors for the CMF HRA - 59PH Repowered

Notch / Duty Cycle	Power in Notch (bhp)	Fuel Rate (lb/hr)	BSFC (lb/bhp-hr)	DPM Emission Factor g/hr	DPM Emission Factor g/bhp-hr
Idle	11	24	2.30	8.7	0.83
DB	11	24	2.30	8.7	0.83
1	200	82	0.41	16.9	0.08
2	365	140	0.38	29.4	0.08
3	703	253	0.36	71.7	0.10
4	1,040	367	0.35	127.4	0.12
5	1,379	479	0.35	186.1	0.13
6	1,697	582	0.34	249.1	0.15
7	2,532	841	0.33	436.3	0.17
8	3,144	1,056	0.34	550.5	0.18
LHDC	828	293	0.35	135.8	0.16
CMFS	217	91	0.42	24.0	0.11
CMFL	1,735	591	0.34	276.8	0.16
CMFM	309	122	0.40	37.5	0.12
CMFMX	309	122	0.40	37.5	0.12
CMFB	932	330	0.35	110.5	0.12
CMFBX	932	330	0.35	110.5	0.12
CMFI	11	24	2.30	8.7	0.83
CMFIX	11	24	2.30	8.7	0.83
ML3	703	253	0.36	71.7	0.10
ML45	1,209	423	0.35	156.7	0.13
ML56	1,538	530	0.34	217.6	0.14

Notes:

1. A deterioration factor of 1.15 was applied to PM emissions (EPA 1998, Appendix B).
2. PM emissions were adjusted to account for a 15 ppm sulfur content of CARB diesel fuel using CARB methodology (ARB. 2005a. OFFROAD Modeling Change Technical Memo, "Changes to the Locomotive Inventory," prepared by Walter Wong, preliminary draft. March 16, 2005. Available online March 31, 2006: http://www.arb.ca.gov/msei/on-road/downloads/docs/Locomotive_Memo.pdf).
3. LHDC = EPA line haul locomotive duty cycle; CMFS = CMF switching duty cycle; CMFL = CMF load test duty cycle; CMFM = CMF train movement duty cycle while loco is not producing aux power; CMFMX = CMF train movement duty cycle while loco is producing aux power; CMFB = CMF brake test duty cycle while loco is not producing aux power; CMFBX = CMF brake test duty cycle while loco is producing aux power; CMFI = CMF idling duty cycle while loco is not producing aux power; CMFIX = CMF idling duty cycle while loco is producing aux power; ML3 = traveling on mainline at Notch 3; ML45 = traveling on mainline at Notches 4 and 5; ML56 = traveling on mainline at Notches 5 and 6.

Table B-31. Exit Velocity and Exhaust Temperature by Notch for Locomotive Main Engine

Notch	Exit Vel (m/s)	Exhaust Temp (K)
Idle	3.73	351
DB	9.46	387
1	4.80	385
2	6.85	451
3	9.70	504
4	12.09	545
5	15.10	584
6	18.10	616
7	22.49	660
8	26.89	661

Source: Roseville Rail Yard Study. Appendix B, Engine 16-645E3B.

Table B-32. Exit Velocity and Exhaust Temperature by Locomotive Duty Cycle

Operating Mode	Duty Cycle	Exit Vel (m/s)	Exhaust Temp (K)
Locomotive Idling except Notch 8	CMFI	3.73	351
Locomotive Idling at Notch 8	CMFIX	26.89	661
Locomotive Brake Test except Notch 8	CMFB	11.38	530
Locomotive Brake Test at Notch 8	CMFBX	26.89	661
Locomotive CMF Movement except Notch 8	CMFM	6.18	413
Locomotive CMF Movement at Notch 8	CMFMX	26.89	661
Locomotive Yard Switching	CMFS	5.42	399
Locomotive Load Testing	CMFL	16.98	573
Offsite Passenger Train Travel at Notch 3	ML3	9.70	504
Offsite Passenger Train Travel at Notch 4/5	ML45	13.60	565
Offsite Passenger Train Travel at Notch 5/6	ML56	16.60	600

Note: Values by notch are averaged over the appropriate duty cycle.

Table B-33. Emissions from Loco Main Engines - Idling while Loco is Producing Aux Power - 2010

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	9,677	CMFIX	35.7	761.5
F59PHI	27%	9,031	CMFIX	19.6	389.3
F40PH	1%	484	CMFIX	872.7	930.8
MP36PH-3C	29%	9,677	CMFIX	3.5	73.7
59PH Repowered	14%	4,516	CMFIX	8.7	86.7
F125	0%	0	CMFIX	7.4	0.0
Total	**100%**	**33,384**			**2,241.9**

Table B-34. Emissions from Loco Main Engines - Idling while Loco is Producing Aux Power - 2012

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	3,354	CMFIX	35.7	263.9
F59PHI	27%	3,130	CMFIX	19.6	134.9
F40PH	1%	168	CMFIX	872.7	322.6
MP36PH-3C	29%	3,354	CMFIX	3.5	25.5
59PH Repowered	14%	1,565	CMFIX	8.7	30.1
F125	0%	0	CMFIX	7.4	0.0
Total	**100%**	**11,571**			**777.1**

Table B-35. Emissions from Loco Main Engines - Idling while Loco is Producing Aux Power - 2014

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	2,592	CMFIX	35.7	204.0
F59PHI	27%	2,419	CMFIX	19.6	104.3
F40PH	1%	130	CMFIX	872.7	249.3
MP36PH-3C	29%	2,592	CMFIX	3.5	19.7
59PH Repowered	14%	1,209	CMFIX	8.7	23.2
F125	0%	0	CMFIX	7.4	0.0
Total	**100%**	**8,942**			**600.5**

Table B-36. Emissions from Loco Main Engines - Idling while Loco is Producing Aux Power - 2017

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	8%	752	CMFIX	35.7	59.2
F59PHI	8%	752	CMFIX	19.6	32.4
F40PH	0%	0	CMFIX	872.7	0.0
MP36PH-3C	25%	2,257	CMFIX	3.5	17.2
59PH Repowered	12%	1,053	CMFIX	8.7	20.2
F125	46%	4,127	CMFIX	7.4	67.8
Total	**100%**	**8,942**			**196.8**

Table B-37. Emissions from Loco Main Engines - Idling while Loco is Not Producing Aux Power - 2010

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	1,801	CMFI	35.7	141.8
F59PHI	27%	1,681	CMFI	19.6	72.5
F40PH	1%	90	CMFI	55.1	10.9
MP36PH-3C	29%	1,801	CMFI	3.5	13.7
59PH Repowered	14%	841	CMFI	8.7	16.1
F125	0%	0	CMFI	1.7	0.0
Total	**100%**	**6,215**			**255.0**

Table B-38. Emissions from Loco Main Engines - Idling while Loco is Not Producing Aux Power - 2012

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	2,996	CMFI	35.7	235.8
F59PHI	27%	2,797	CMFI	19.6	120.5
F40PH	1%	150	CMFI	55.1	18.2
MP36PH-3C	29%	2,996	CMFI	3.5	22.8
59PH Repowered	14%	1,398	CMFI	8.7	26.9
F125	0%	0	CMFI	1.7	0.0
Total	**100%**	**10,338**			**424.2**

Table B-39. Emissions from Loco Main Engines - Idling while Loco is Not Producing Aux Power - 2014

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	2,549	CMFI	35.7	200.6
F59PHI	27%	2,379	CMFI	19.6	102.6
F40PH	1%	127	CMFI	55.1	15.5
MP36PH-3C	29%	2,549	CMFI	3.5	19.4
59PH Repowered	14%	1,190	CMFI	8.7	22.8
F125	0%	0	CMFI	1.7	0.0
Total	**100%**	**8,796**			**360.9**

Table B-40. Emissions from Loco Main Engines - Idling while Loco is Not Producing Aux Power - 2017

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	8%	740	CMFI	35.7	58.2
F59PHI	8%	740	CMFI	19.6	31.9
F40PH	0%	0	CMFI	55.1	0.0
MP36PH-3C	25%	2,220	CMFI	3.5	16.9
59PH Repowered	12%	1,036	CMFI	8.7	19.9
F125	46%	4,060	CMFI	1.7	15.5
Total	**100%**	**8,796**			**142.5**

Table B-41. Emissions from Loco Main Engines - Brake Test while Loco is Producing Aux Power - 2010

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	438	CMFBX	237.5	229.2
F59PHI	27%	409	CMFBX	248.0	223.4
F40PH	1%	22	CMFBX	872.7	42.1
MP36PH-3C	29%	438	CMFBX	145.8	140.7
59PH Repowered	14%	204	CMFBX	110.5	49.8
F125	0%	0	CMFBX	33.9	0.0
Total	**100%**	**1,510**			**685.2**

Table B-42. Emissions from Loco Main Engines - Brake Test while Loco is Producing Aux Power - 2012

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	268	CMFBX	237.5	140.5
F59PHI	27%	250	CMFBX	248.0	136.9
F40PH	1%	13	CMFBX	872.7	25.8
MP36PH-3C	29%	268	CMFBX	145.8	86.2
59PH Repowered	14%	125	CMFBX	110.5	30.5
F125	0%	0	CMFBX	33.9	0.0
Total	**100%**	**926**			**420.0**

Table B-43. Emissions from Loco Main Engines - Brake Test while Loco is Producing Aux Power - 2014

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	104	CMFBX	237.5	54.4
F59PHI	27%	97	CMFBX	248.0	53.0
F40PH	1%	5	CMFBX	872.7	10.0
MP36PH-3C	29%	104	CMFBX	145.8	33.4
59PH Repowered	14%	49	CMFBX	110.5	11.8
F125	0%	0	CMFBX	33.9	0.0
Total	**100%**	**359**			**162.7**

Table B-44. Emissions from Loco Main Engines - Brake Test while Loco is Producing Aux Power - 2017

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	8%	30	CMFBX	237.5	15.8
F59PHI	8%	30	CMFBX	248.0	16.5
F40PH	0%	0	CMFBX	872.7	0.0
MP36PH-3C	25%	91	CMFBX	145.8	29.1
59PH Repowered	12%	42	CMFBX	110.5	10.3
F125	46%	166	CMFBX	33.9	12.4
Total	**100%**	**359**			**84.1**

Table B-45. Emissions from Loco Main Engines - Brake Test while Loco is Not Producing Aux Power - 2010

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	0	CMFB	237.5	0.0
F59PHI	27%	0	CMFB	248.0	0.0
F40PH	1%	0	CMFB	257.2	0.0
MP36PH-3C	29%	0	CMFB	145.8	0.0
59PH Repowered	14%	0	CMFB	110.5	0.0
F125	0%	0	CMFB	33.9	0.0
Total	**100%**	**0**			**0.0**

Table B-46. Emissions from Loco Main Engines - Brake Test while Loco is Not Producing Aux Power - 2012

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	169	CMFB	237.5	88.7
F59PHI	27%	158	CMFB	248.0	86.5
F40PH	1%	8	CMFB	257.2	4.8
MP36PH-3C	29%	169	CMFB	145.8	54.5
59PH Repowered	14%	79	CMFB	110.5	19.3
F125	0%	0	CMFB	33.9	0.0
Total	**100%**	**585**			**253.7**

Table B-47. Emissions from Loco Main Engines - Brake Test while Loco is Not Producing Aux Power - 2014

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	265	CMFB	237.5	138.5
F59PHI	27%	247	CMFB	248.0	135.0
F40PH	1%	13	CMFB	257.2	7.5
MP36PH-3C	29%	265	CMFB	145.8	85.0
59PH Repowered	14%	123	CMFB	110.5	30.1
F125	0%	0	CMFB	33.9	0.0
Total	**100%**	**913**			**396.2**

Table B-48. Emissions from Loco Main Engines - Brake Test while Loco is Not Producing Aux Power - 2017

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	8%	77	CMFB	237.5	40.2
F59PHI	8%	77	CMFB	248.0	42.0
F40PH	0%	0	CMFB	257.2	0.0
MP36PH-3C	25%	230	CMFB	145.8	74.0
59PH Repowered	12%	108	CMFB	110.5	26.2
F125	46%	421	CMFB	33.9	31.5
Total	**100%**	**913**			**214.0**

Table B-49. Emissions from Loco Main Engines - Train Movements while Loco is Producing Aux Power - 2010

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	1,220	CMFMX	98.4	264.6
F59PHI	27%	1,138	CMFMX	84.2	211.3
F40PH	1%	61	CMFMX	872.7	117.3
MP36PH-3C	29%	1,220	CMFMX	52.7	141.7
59PH Repowered	14%	569	CMFMX	37.5	47.1
F125	0%	0	CMFMX	14.8	0.0
Total	**100%**	**4,208**			**782.0**

Table B-50. Emissions from Loco Main Engines - Train Movements while Loco is Producing Aux Power - 2012

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	207	CMFMX	98.4	44.9
F59PHI	27%	193	CMFMX	84.2	35.8
F40PH	1%	10	CMFMX	872.7	19.9
MP36PH-3C	29%	207	CMFMX	52.7	24.0
59PH Repowered	14%	97	CMFMX	37.5	8.0
F125	0%	0	CMFMX	14.8	0.0
Total	**100%**	**714**			**132.7**

Table B-51. Emissions from Loco Main Engines - Train Movements while Loco is Producing Aux Power - 2014

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	174	CMFMX	98.4	37.8
F59PHI	27%	163	CMFMX	84.2	30.2
F40PH	1%	9	CMFMX	872.7	16.8
MP36PH-3C	29%	174	CMFMX	52.7	20.2
59PH Repowered	14%	81	CMFMX	37.5	6.7
F125	0%	0	CMFMX	14.8	0.0
Total	**100%**	**601**			**111.7**

Table B-52. Emissions from Loco Main Engines - Train Movements while Loco is Producing Aux Power - 2017

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	8%	51	CMFMX	98.4	11.0
F59PHI	8%	51	CMFMX	84.2	9.4
F40PH	0%	0	CMFMX	872.7	0.0
MP36PH-3C	25%	152	CMFMX	52.7	17.6
59PH Repowered	12%	71	CMFMX	37.5	5.9
F125	46%	277	CMFMX	14.8	9.0
Total	**100%**	**601**			**52.9**

Table B-53. Emissions from Loco Main Engines - Train Movements while Loco is Not Producing Aux Power - 2010

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	0	CMFM	98.4	0.0
F59PHI	27%	0	CMFM	84.2	0.0
F40PH	1%	0	CMFM	116.9	0.0
MP36PH-3C	29%	0	CMFM	52.7	0.0
59PH Repowered	14%	0	CMFM	37.5	0.0
F125	0%	0	CMFM	12.1	0.0
Total	**100%**	**0**			**0.0**

Table B-54. Emissions from Loco Main Engines - Train Movements while Loco is Not Producing Aux Power - 2012

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	1,013	CMFM	98.4	219.7
F59PHI	27%	945	CMFM	84.2	175.4
F40PH	1%	51	CMFM	116.9	13.1
MP36PH-3C	29%	1,013	CMFM	52.7	117.6
59PH Repowered	14%	473	CMFM	37.5	39.1
F125	0%	0	CMFM	12.1	0.0
Total	**100%**	**3,494**			**564.9**

Table B-55. Emissions from Loco Main Engines - Train Movements while Loco is Not Producing Aux Power - 2014

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	29%	794	CMFM	98.4	172.2
F59PHI	27%	741	CMFM	84.2	137.5
F40PH	1%	40	CMFM	116.9	10.2
MP36PH-3C	29%	794	CMFM	52.7	92.2
59PH Repowered	14%	370	CMFM	37.5	30.6
F125	0%	0	CMFM	12.1	0.0
Total	**100%**	**2,738**			**442.7**

Table B-56. Emissions from Loco Main Engines - Train Movements while Loco is Not Producing Aux Power - 2017

Loco Model	Percent Usage	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	8%	230	CMFM	98.4	50.0
F59PHI	8%	230	CMFM	84.2	42.8
F40PH	0%	0	CMFM	116.9	0.0
MP36PH-3C	25%	691	CMFM	52.7	80.3
59PH Repowered	12%	322	CMFM	37.5	26.7
F125	46%	1,264	CMFM	12.1	33.6
Total	**100%**	**2,738**			**233.3**

Table B-57. Emissions from Loco Main Engines - Yard Switching - 2010

Loco Model	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	98	CMFS	84.6	18.3
F59PHI	91	CMFS	53.9	10.9
F40PH	5	CMFS	100.3	1.1
MP36PH-3C	0	CMFS	32.2	0.0
59PH Repowered	46	CMFS	24.0	2.4
F125	0	CMFS	9.6	0.0
Total	**240**			**32.6**

Table B-58. Emissions from Loco Main Engines - Yard Switching - 2012

Loco Model	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	98	CMFS	84.6	18.3
F59PHI	91	CMFS	53.9	10.9
F40PH	5	CMFS	100.3	1.1
MP36PH-3C	0	CMFS	32.2	0.0
59PH Repowered	46	CMFS	24.0	2.4
F125	0	CMFS	9.6	0.0
Total	**240**			**32.6**

Table B-59. Emissions from Loco Main Engines - Yard Switching - 2014

Loco Model	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	37	CMFS	84.6	6.9
F59PHI	34	CMFS	53.9	4.1
F40PH	2	CMFS	100.3	0.4
MP36PH-3C	0	CMFS	32.2	0.0
59PH Repowered	17	CMFS	24.0	0.9
F125	0	CMFS	9.6	0.0
Total	**90**			**12.2**

Table B-60. Emissions from Loco Main Engines - Yard Switching - 2017

Loco Model	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	26	CMFS	84.6	4.9
F59PHI	26	CMFS	53.9	3.1
F40PH	0	CMFS	100.3	0.0
MP36PH-3C	0	CMFS	32.2	0.0
59PH Repowered	37	CMFS	24.0	2.0
F125	0	CMFS	9.6	0.0
Total	**90**			**10.0**

Table B-61. Emissions from Loco Main Engines - Load Testing - 2010

Loco Model	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	75	CMFL	425.9	70.4
F59PHI	70	CMFL	621.3	95.9
F40PH	5	CMFL	486.9	5.4
MP36PH-3C	75	CMFL	302.0	49.9
59PH Repowered	35	CMFL	276.8	21.4
F125	0	CMFL	38.0	0.0
Total	**260**			**243.0**

Table B-62. Emissions from Loco Main Engines - Load Testing - 2012

Loco Model	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	75	CMFL	425.9	70.4
F59PHI	70	CMFL	621.3	95.9
F40PH	5	CMFL	486.9	5.4
MP36PH-3C	75	CMFL	302.0	49.9
59PH Repowered	35	CMFL	276.8	21.4
F125	0	CMFL	38.0	0.0
Total	**260**			**243.0**

Table B-63. Emissions from Loco Main Engines - Load Testing - 2014

Loco Model	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	75	CMFL	425.9	70.4
F59PHI	70	CMFL	621.3	95.9
F40PH	5	CMFL	486.9	5.4
MP36PH-3C	75	CMFL	302.0	49.9
59PH Repowered	35	CMFL	276.8	21.4
F125	0	CMFL	38.0	0.0
Total	**260**			**243.0**

Table B-64. Emissions from Loco Main Engines - Load Testing - 2017

Loco Model	Duration (hr/yr)	Duty Cycle	DPM Emission Factor (g/hr)	DPM Emission Rate (lb/yr)
F59PH	25	CMFL	425.9	23.5
F59PHI	25	CMFL	621.3	34.2
F40PH	0	CMFL	486.9	0.0
MP36PH-3C	75	CMFL	302.0	49.9
59PH Repowered	35	CMFL	276.8	21.4
F125	100	CMFL	38.0	8.4
Total	**260**			**137.4**

Table B-65. Emissions from HEP Engines, Yard Equipment, and Trucks on the CMF - 2010

Equipment ID	Equipment Model Year	Engine Size (hp)	Load Factor	Annual Activity	Activity Units	BSFC (lb fuel/hp-hr)	DPM Emission Factor	Emission Factor Units	DPM Emission Rate (lb/yr)
HEP Engines on Trains									
HEP1	1992	536		1,655,147	hp-hr/yr	0.3670	0.448	g/hp-hr	1,635.2
HEP2	2001	536		472,899	hp-hr/yr	0.3670	0.169	g/hp-hr	176.0
HEP3	2006	976		3,901,419	hp-hr/yr	0.3670	0.116	g/hp-hr	997.3
HEP Engine Load Tests									
HEP1	1992	536		14,817	hp-hr/yr	0.3670	0.448	g/hp-hr	14.6
HEP2	2001	536		4,233	hp-hr/yr	0.3670	0.169	g/hp-hr	1.6
HEP3	2006	976		34,926	hp-hr/yr	0.3670	0.116	g/hp-hr	8.9
Yard Equipment									
Emergency Generator 1	1992	220	1.0000	22	hr/yr	0.3670	0.512	g/hp-hr	5.5
Emergency Generator 2	1992	535	1.0000	25	hr/yr	0.3670	0.448	g/hp-hr	13.2
Forklift 5-ton	1992	100	0.201	120	hr/yr	0.3691	0.936	g/hp-hr	5.0
Forklift 1.5-ton	1992	45	0.201	120	hr/yr	0.4094	1.060	g/hp-hr	2.5
Welder	2005	13	0.3417	180	hr/yr	0.4095	0.413	g/hp-hr	0.8
Rail Car Mover	2002	152	0.3417	1,760	hr/yr	0.3670	0.456	g/hp-hr	92.0
Trucks									
Locomotive Fueling Truck -Transit	1997	250		288	miles/yr		2.369	g/mile	1.5
Fuel Delivery Trucks - Transit	Fleet Average			374	miles/yr		2.083	g/mile	1.7
Vendor Delivery Trucks - Transit	Fleet Average			624	miles/yr		1.371	g/mile	1.9
Locomotive Fueling Truck - Idling	1997	250		24	hr/yr		1.695	g/hr	0.1
Fuel Delivery Trucks - Idling	Fleet Average			78	hr/yr		1.009	g/hr	0.2
Vendor Delivery Trucks - Idling	Fleet Average			22	hr/yr		1.153	g/hr	0.1

Notes:
1. Source for HEP engine and yard equipment emission factors: CARB, Mobile Source Emission Inventory - Off-Road Diesel Equipment - In-Use Off-Road Equipment (Construction, Industrial, Ground Support and Oil Drilling) - 2011 Inventory Model. Website: http://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles. Run date April 1, 2013 for South Coast Air Basin equipment population.
2. Source for truck emission factors: CARB, EMFAC2011. Website: http://www.arb.ca.gov/msei/modeling.htm#emfac2011_web_based_data. Run for the South Coast Air Basin vehicle population on May 15, 2012.

Table B-66. Emissions from HEP Engines, Yard Equipment, and Trucks on the CMF - 2012

Equipment ID	Equipment Model Year	Engine Size (hp)	Load Factor	Annual Activity	Activity Units	BSFC (lb fuel/hp-hr)	DPM Emission Factor	Emission Factor Units	DPM Emission Rate (lb/yr)
HEP Engines on Trains									
HEP1	1992	536		568,725	hp-hr/yr	0.3670	0.448		561.9
HEP2	2001	536		162,493	hp-hr/yr	0.3670	0.179		64.0
HEP3	2006	976		1,340,566	hp-hr/yr	0.3670	0.124		366.3
HEP Engine Load Tests									
HEP1	1992	536		14,817	hp-hr/yr	0.3670	0.448		14.6
HEP2	2001	536		4,233	hp-hr/yr	0.3670	0.179		1.7
HEP3	2006	976		34,926	hp-hr/yr	0.3670	0.124		9.5
Yard Equipment									
Emergency Generator 1	1992	220	1.0000	22	hr/yr	0.3670	0.512		5.5
Emergency Generator 2	1992	535	1.0000	25	hr/yr	0.3670	0.448		13.2
Forklift 5-ton	1992	100	0.201	120	hr/yr	0.3696	0.937		5.0
Forklift 1.5-ton	1992	45	0.201	120	hr/yr	0.4094	1.060		2.5
Welder	2005	13	0.3417	180	hr/yr	0.4095	0.449		0.8
Rail Car Mover	2002	152	0.3417	1,760	hr/yr	0.3670	0.490		98.8
Trucks									
Locomotive Fueling Truck -Transit	1997	250		288	miles/yr		1.535		1.0
Fuel Delivery Trucks - Transit	Fleet Average			374	miles/yr		1.533		1.3
Vendor Delivery Trucks - Transit	Fleet Average			624	miles/yr		1.067		1.5
Locomotive Fueling Truck - Idling	1997	250		24	hr/yr		1.695		0.1
Fuel Delivery Trucks - Idling	Fleet Average			78	hr/yr		0.721		0.1
Vendor Delivery Trucks - Idling	Fleet Average			22	hr/yr		0.904		0.0

Notes:

1. Source for HEP engine and yard equipment emission factors: CARB, Mobile Source Emission Inventory - Off-Road Diesel Equipment - In-Use Off-Road Equipment (Construction, Industrial, Ground Support and Oil Drilling) - 2011 Inventory Model. Website: http://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles. Run date April 1, 2013 for South Coast Air Basin equipment population.
2. Source for truck emission factors: CARB, EMFAC2011. Website: http://www.arb.ca.gov/msei/modeling.htm#emfac2011_web_based_data. Run for the South Coast Air Basin vehicle population on May 15, 2012.

Table B-67. Emissions from HEP Engines, Yard Equipment, and Trucks on the CMF - 2014

Equipment ID	Equipment Model Year	Engine Size (hp)	Load Factor	Annual Activity	Activity Units	BSFC (lb fuel/hp-hr)	DPM Emission Factor	Emission Factor Units	DPM Emission Rate (lb/yr)
HEP Engines on Trains									
HEP1	1992	536		425,812	hp-hr/yr	0.3670	0.448		420.7
HEP2	2001	536		121,661	hp-hr/yr	0.3670	0.179		47.9
HEP3	2006	976		1,003,700	hp-hr/yr	0.3670	0.132		291.9
HEP Engine Load Tests									
HEP1	1992	536		14,817	hp-hr/yr	0.3670	0.448		14.6
HEP2	2001	536		4,233	hp-hr/yr	0.3670	0.179		1.7
HEP3	2006	976		34,926	hp-hr/yr	0.3670	0.132		10.2
Yard Equipment									
Emergency Generator 1	1992	220	1.0000	22	hr/yr	0.3670	0.512		5.5
Emergency Generator 2	1992	535	1.0000	25	hr/yr	0.3670	0.448		13.2
Forklift 5-ton	1992	100	0.201	120	hr/yr	0.3700	0.938		5.0
Forklift 1.5-ton	1992	45	0.201	120	hr/yr	0.4094	1.060		2.5
Welder	2005	13	0.3417	180	hr/yr	0.4096	0.485		0.9
Rail Car Mover	2002	152	0.3417	150	hr/yr	0.3670	0.524		9.0
Trucks									
Locomotive Fueling Truck -Transit	1997	250		0	miles/yr		0.711		0.0
Fuel Delivery Trucks - Transit	Fleet Average			374	miles/yr		0.728		0.6
Vendor Delivery Trucks - Transit	Fleet Average			624	miles/yr		0.488		0.7
Locomotive Fueling Truck - Idling	1997	250		0	hr/yr		1.695		0.0
Fuel Delivery Trucks - Idling	Fleet Average			66	hr/yr		0.333		0.0
Vendor Delivery Trucks - Idling	Fleet Average			22	hr/yr		0.529		0.0

Notes:

1. Source for HEP engine and yard equipment emission factors: CARB, Mobile Source Emission Inventory - Off-Road Diesel Equipment - In-Use Off-Road Equipment (Construction, Industrial, Ground Support and Oil Drilling) - 2011 Inventory Model. Website: http://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles. Run date April 1, 2013 for South Coast Air Basin equipment population.
2. Source for truck emission factors: CARB, EMFAC2011. Website: http://www.arb.ca.gov/msei/modeling.htm#emfac2011_web_based_data. Run for the South Coast Air Basin vehicle population on May 15, 2012.

Table B-68. Emissions from HEP Engines, Yard Equipment, and Trucks on the CMF - 2017

Equipment ID	Equipment Model Year	Engine Size (hp)	Load Factor	Annual Activity	Activity Units	BSFC (lb fuel/hp-hr)	DPM Emission Factor	Emission Factor Units	DPM Emission Rate (lb/yr)
HEP Engines on Trains									
HEP1	1992	536		0	hp-hr/yr	0.3670	0.448		0.0
HEP2	2001	536		0	hp-hr/yr	0.3670	0.179		0.0
HEP3	2006	976		847,530	hp-hr/yr	0.3670	0.144		268.8
HEP Engine Load Tests									
HEP1	1992	536		0	hp-hr/yr	0.3670	0.448		0.0
HEP2	2001	536		0	hp-hr/yr	0.3670	0.179		0.0
HEP3	2006	976		29,491	hp-hr/yr	0.3670	0.144		9.4
Yard Equipment									
Emergency Generator 1	1992	220	1.0000	22	hr/yr	0.3670	0.512		5.5
Emergency Generator 2	1992	535	1.0000	25	hr/yr	0.3670	0.448		13.2
Forklift 5-ton	1992	100	0.201	120	hr/yr	0.3708	0.940		5.0
Forklift 1.5-ton	1992	45	0.201	120	hr/yr	0.4093	1.059		2.5
Welder	2005	13	0.3417	180	hr/yr	0.4097	0.540		1.0
Rail Car Mover	2002	152	0.3417	150	hr/yr	0.3670	0.569		9.8
Trucks									
Locomotive Fueling Truck -Transit	1997	250		0	miles/yr		0.414		0.0
Fuel Delivery Trucks - Transit	Fleet Average			374	miles/yr		0.140		0.1
Vendor Delivery Trucks - Transit	Fleet Average			624	miles/yr		0.103		0.1
Locomotive Fueling Truck - Idling	1997	250		0	hr/yr		1.695		0.0
Fuel Delivery Trucks - Idling	Fleet Average			66	hr/yr		0.125		0.0
Vendor Delivery Trucks - Idling	Fleet Average			22	hr/yr		0.235		0.0

Notes:

1. Source for HEP engine and yard equipment emission factors: CARB, Mobile Source Emission Inventory - Off-Road Diesel Equipment - In-Use Off-Road Equipment (Construction, Industrial, Ground Support and Oil Drilling) - 2011 Inventory Model. Website: http://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles. Run date April 1, 2013 for South Coast Air Basin equipment population.
2. Source for truck emission factors: CARB, EMFAC2011. Website: http://www.arb.ca.gov/msei/modeling.htm#emfac2011_web_based_data. Run for the South Coast Air Basin vehicle population on May 15, 2012.

Table B-69. HEP Engine Performance Data - CAT 3406

Power Produced (ekW)	Percent Load	Engine Power (bhp)	Fuel Rate (GPH)	Exh Stack Temp (F)	Exh Gas Flow (acfm)
365	100	536	25.99	1,004	3,069
328.5	90	482	23.06	973	2,755
292	80	429	20.39	944	2,461
273.8	75	403	19.15	930	2,324
255.5	70	377	17.94	915	2,190
219	60	325	15.59	883	1,925
182.5	50	274	13.37	848	1,677
146	40	224	11.23	802	1,448
109.5	30	173	9.11	740	1,229
91.3	25	148	8.03	704	1,123
73	20	121	6.95	661	1,024
36.5	10	68	4.78	555	840

Notes:
1. The engine also runs a cooling fan which consumes some of the engine power.
2. Source: Caterpillar. Gen Set Package Performance Data [1LS01754]. Model 3406CDITA. 3/25/2014.

Table B-70. HEP Engine Performance Data - CAT C27

Power Produced (ekW)	Percent Load	Engine Power (bhp)	Fuel Rate (GPH)	Exh Stack Temp (F)	Exh Gas Flow (acfm)
635	100	976	46.1	942	4,845
571.5	90	879	41.9	923	4,480
508	80	781	37.7	903	4,128
476.25	75	732	35.6	891	3,959
444.5	70	683	33.6	877	3,790
381	60	586	29.4	845	3,437
317.5	50	488	25	797	3,003
254	40	391	20.3	727	2,505
190.5	30	293	15.7	642	2,039
158.75	25	244	13.5	594	1,843
127	20	195	11.4	542	1,677
63.5	10	97.6	7.5	428	1,403

Notes:
1. The engine also runs a cooling fan which consumes some of the engine power.
2. Source: Caterpillar. Performance Data [TWM01863]. Model C27. 3/25/2014.

Table B-71. Determine Stack Parameters for HEP Engines

Status	Engine power (bhp)	3406 Temp (F)	3406 Flow Rate (acfm)	C27 Temp (F)	C27 Flow Rate (acfm)	Avg Temp (K)	Avg Flow Rate (acfm)	Stack Diameter (ft)	Stack Exit Vel (m/s)
Load Test	346	896	2,032	688	2,291	695	2,161	0.471	62.9
Normal Operation	155	714	1,152	495	1,564	591	1,358	0.471	39.5

Note: Engine power and stack diameter were provided by Metrolink.

Table B-72. CMF Diesel Equipment Emissions by Source - 2010

Emission Source	DPM Emission Rate (ton/yr)
Locomotives	
Locomotive Idling except Notch 8	0.78
Locomotive Idling at Notch 8	0.47
Locomotive Brake Test except Notch 8	0.32
Locomotive Brake Test at Notch 8	0.02
Locomotive Movement except Notch 8	0.33
Locomotive Movement at Notch 8	0.06
Locomotive Yard Switching	0.02
Locomotive Load Testing	0.12
Subtotal - Locomotives	**2.12**
HEP Engines	
HEP Engines on Trains	1.40
HEP Engine Load Testing	0.01
Subtotal - HEP Engines	**1.42**
Diesel Yard Equipment	
Emergency Generator 1	0.00
Emergency Generator 2	0.01
Forklifts and Welder	0.00
Rail Car Mover	0.05
Subtotal - Diesel Yard Equipment	**0.06**
Diesel Trucks On-Site	**0.00**
Grand Total	**3.60**

Notes:

1. Emissions represent diesel equipment activity within the boundaries of the CMF.

Table B-73. CMF Diesel Equipment Emissions by Source - 2012

Emission Source	DPM Emission Rate (ton/yr)
Locomotives	
Locomotive Idling except Notch 8	0.44
Locomotive Idling at Notch 8	0.16
Locomotive Brake Test except Notch 8	0.32
Locomotive Brake Test at Notch 8	0.01
Locomotive Movement except Notch 8	0.34
Locomotive Movement at Notch 8	0.01
Locomotive Yard Switching	0.02
Locomotive Load Testing	0.12
Subtotal - Locomotives	**1.42**
HEP Engines	
HEP Engines on Trains	0.50
HEP Engine Load Testing	0.01
Subtotal - HEP Engines	**0.51**
Diesel Yard Equipment	
Emergency Generator 1	0.00
Emergency Generator 2	0.01
Forklifts and Welder	0.00
Rail Car Mover	0.05
Subtotal - Diesel Yard Equipment	**0.06**
Diesel Trucks On-Site	**0.00**
Grand Total	**2.00**

Notes:

1. Emissions represent diesel equipment activity within the boundaries of the CMF.

Table B-74. CMF Diesel Equipment Emissions by Source - 2014

Emission Source	DPM Emission Rate (ton/yr)
Locomotives	
Locomotive Idling except Notch 8	0.36
Locomotive Idling at Notch 8	0.12
Locomotive Brake Test except Notch 8	0.27
Locomotive Brake Test at Notch 8	0.00
Locomotive Movement except Notch 8	0.27
Locomotive Movement at Notch 8	0.01
Locomotive Yard Switching	0.01
Locomotive Load Testing	0.12
Subtotal - Locomotives	**1.16**
HEP Engines	
HEP Engines on Trains	0.38
HEP Engine Load Testing	0.01
Subtotal - HEP Engines	**0.39**
Diesel Yard Equipment	
Emergency Generator 1	0.00
Emergency Generator 2	0.01
Forklifts and Welder	0.00
Rail Car Mover	0.00
Subtotal - Diesel Yard Equipment	**0.02**
Diesel Trucks On-Site	**0.00**
Grand Total	**1.58**

Notes:

1. Emissions represent diesel equipment activity within the boundaries of the CMF.

Table B-75. CMF Diesel Equipment Emissions by Source - 2017

Emission Source	DPM Emission Rate (ton/yr)
Locomotives	
Locomotive Idling except Notch 8	0.18
Locomotive Idling at Notch 8	0.00
Locomotive Brake Test except Notch 8	0.18
Locomotive Brake Test at Notch 8	0.00
Locomotive Movement except Notch 8	0.16
Locomotive Movement at Notch 8	0.00
Locomotive Yard Switching	0.01
Locomotive Load Testing	0.07
Subtotal - Locomotives	**0.60**
HEP Engines	
HEP Engines on Trains	0.13
HEP Engine Load Testing	0.00
Subtotal - HEP Engines	**0.14**
Diesel Yard Equipment	
Emergency Generator 1	0.00
Emergency Generator 2	0.01
Forklifts and Welder	0.00
Rail Car Mover	0.00
Subtotal - Diesel Yard Equipment	**0.02**
Diesel Trucks On-Site	**0.00**
Grand Total	**0.76**

Notes:

1. Emissions represent diesel equipment activity within the boundaries of the CMF.

Appendix C

Diesel PM Emission Calculation Tables for Off-Site Sources

List of Tables

Table C-1. Truck Volumes on Prominent Roadways within 1 Mile of CMF - 2010 and 2012

Roadway Segment	Truck Annual Average Daily Traffic (AADT) (vehicles/day, both directions)									
	2010					2012				
	2 axle	3 axle	4 axle	5 axle	Total	2 axle	3 axle	4 axle	5 axle	Total
I-5 south of SR-110	3,461	1,177	383	8,104	13,125	3,800	1,293	421	8,897	14,411
I-5 north of SR-110	3,462	1,178	383	8,105	13,128	3,805	1,294	421	8,908	14,428
SR-110 south of I-5	1,516	182	10	39	1,747	1456	173	9	35	1,673
SR-110 north of I-5	968	20	0	0	988	916	19	0	0	935
San Fernando Road	413	45	10	35	503	415	46	10	35	506
Riverside Drive	235	26	6	20	286	236	26	6	20	288
Figueroa Street	399	44	10	34	486	401	44	10	34	489
Cypress Ave	273	30	7	23	333	275	30	7	23	335
Pasadena Ave	480	53	12	41	586	483	53	12	41	589
Stadium Way	162	18	4	14	198	163	18	4	14	199
W Ave 26	316	35	8	27	386	318	35	8	27	388
North Broadway	41	4	1	3	49	41	4	1	3	50
Eagle Rock Boulevard	1,066	117	26	91	1,300	1,072	118	26	92	1,307

Table C-2. Truck Volumes on Prominent Roadways within 1 Mile of CMF - 2014 and 2017

Roadway Segment	Truck Annual Average Daily Traffic (AADT) (vehicles/day, both directions)									
	2014					2017				
	2 axle	3 axle	4 axle	5 axle	Total	2 axle	3 axle	4 axle	5 axle	Total
I-5 south of SR-110	3,821	1,300	423	8,947	14,491	3,851	1,310	427	9,017	14,606
I-5 north of SR-110	3,826	1,301	423	8,958	14,508	3,856	1,312	427	9,028	14,623
SR-110 south of I-5	1,464	174	9	35	1,682	1,476	175	9	35	1,696
SR-110 north of I-5	921	19	0	0	940	928	19	0	0	948
San Fernando Road	417	46	10	36	509	421	46	10	36	513
Riverside Drive	237	26	6	20	290	239	26	6	20	292
Figueroa Street	403	44	10	34	491	406	45	10	35	495
Cypress Ave	276	30	7	24	337	278	31	7	24	340
Pasadena Ave	486	53	12	41	592	490	54	12	42	597
Stadium Way	164	18	4	14	200	165	18	4	14	202
W Ave 26	320	35	8	27	390	322	35	8	28	393
North Broadway	41	5	1	4	50	41	5	1	4	50
Eagle Rock Boulevard	1,078	118	26	92	1,315	1,086	119	26	93	1,325

Notes:

1. Source for I-5 and SR-110 traffic volumes: California Department of Transportation (Caltrans). Traffic Census. "2010Truck.xlsx" and "2012Truck.xlsx". Website: http://traffic-counts.dot.ca.gov/. Website accessed 6/24/2014.
2. Source for surface street traffic volumes: SCAG Travel Demand Model, LADOT traffic counts, and Metro traffic counts, as provided by Iteris (personal communication with Sean Daly, 5/15/2014). Total volumes were apportioned by axle using Caltrans data (see reference above) for representative state highways on surface streets (SR-2 and SR-187).
3. Volumes were scaled to the various analysis years using growth factors provided by Metro.

Table C-3. Traffic Volume Growth Factors

Year	Factor
2010	1.000
2011	1.003
2012	1.006
2013	1.008
2014	1.011
2015	1.014
2016	1.017
2017	1.019
2018	1.022
2019	1.024
2020	1.027

Notes:

1. Source: Los Angeles County Metropolitan Transportation Authority (Metro). 2010 Congestion Management Program. Undated. Exhibit D-1. RSA 24 (Glendale).
2. Factors were provided for 2010, 2015, and 2020, and are relative to 2010. Interim years were interpolated.

Table C-4. Roadway Average Travel Speeds and Segment Length within 1 Mile of CMF

Roadway Segment	Average Speed (mph)	Length (meters)	Length (miles)
I-5 south of SR-110	55	1,466	0.91
I-5 north of SR-110	55	3,362	2.09
SR-110 south of I-5	55	1,442	0.90
SR-110 north of I-5	55	1,863	1.16
San Fernando Road	20	3,276	2.04
Riverside Drive	20	3,373	2.10
Figueroa Street	20	1,943	1.21
Cypress Ave	20	2,760	1.71
Pasadena Ave	20	2,603	1.62
Stadium Way	20	1,704	1.06
W Ave 26	20	1,458	0.91
North Broadway	20	1,923	1.19
Eagle Rock Boulevard	20	504	0.31

Notes:

1. Average speeds for 1-5 and SR-110 were derived from PeMS data; truck speeds were capped at 55 mph. Average speeds for surface streets were provided by Iteris (2014). Speeds are rounded to the nearest 5 mph.

Table C-5. Truck VMT for Roadways within 1 Mile of CMF - 2010 and 2012

	Truck Average Daily Vehicle-Miles Traveled (VMT) (miles/day)									
	2010					2012				
Roadway Segment	2 axle	3 axle	4 axle	5 axle	Total	2 axle	3 axle	4 axle	5 axle	Total
I-5 south of SR-110	3,152	1,072	349	7,381	11,954	3,461	1,178	383	8,103	13,126
I-5 north of SR-110	7,232	2,461	800	16,931	27,424	7,949	2,703	879	18,609	30,140
SR-110 south of I-5	1,358	163	9	35	1,565	1,305	155	8	31	1,499
SR-110 north of I-5	1,121	23	0	0	1,144	1,061	22	0	0	1,083
San Fernando Road	840	92	20	72	1,024	845	93	21	72	1,030
Riverside Drive	492	54	12	42	600	495	54	12	42	604
Figueroa Street	481	53	12	41	587	484	53	12	41	590
Cypress Ave	468	51	11	40	571	471	52	11	40	575
Pasadena Ave	777	85	19	66	947	781	86	19	67	953
Stadium Way	172	19	4	15	209	173	19	4	15	211
W Ave 26	287	31	7	24	350	288	32	7	25	352
North Broadway	48	5	1	4	59	49	5	1	4	59
Eagle Rock Boulevard	334	37	8	29	407	336	37	8	29	410

Table C-6. Truck VMT for Roadways within 1 Mile of CMF - 2014 and 2017

	Truck Average Daily Vehicle-Miles Traveled (VMT) (miles/day)									
	2014					2017				
Roadway Segment	2 axle	3 axle	4 axle	5 axle	Total	2 axle	3 axle	4 axle	5 axle	Total
I-5 south of SR-110	3,480	1,184	386	8,149	13,199	3,508	1,194	389	8,213	13,303
I-5 north of SR-110	7,993	2,718	884	18,712	30,308	8,056	2,740	891	18,860	30,548
SR-110 south of I-5	1,312	156	8	32	1,508	1,322	157	8	32	1,519
SR-110 north of I-5	1,066	22	0	0	1,089	1,075	22	0	0	1,097
San Fernando Road	849	93	21	73	1,036	856	94	21	73	1,044
Riverside Drive	498	55	12	42	607	502	55	12	43	612
Figueroa Street	487	53	12	42	593	490	54	12	42	598
Cypress Ave	474	52	12	40	578	477	52	12	41	582
Pasadena Ave	786	86	19	67	958	792	87	19	68	966
Stadium Way	174	19	4	15	212	175	19	4	15	213
W Ave 26	290	32	7	25	353	292	32	7	25	356
North Broadway	49	5	1	4	60	49	5	1	4	60
Eagle Rock Boulevard	338	37	8	29	412	340	37	8	29	415

Table C-7. Truck DPM Emission Factors - 2010 and 2012

Roadway Segment	DPM Emission Factor (g/mi)							
	2010				2012			
	2 axle	3 axle	4 axle	5 axle	2 axle	3 axle	4 axle	5 axle
I-5 south of SR-110	0.007	0.208	0.438	0.438	0.006	0.176	0.342	0.342
I-5 north of SR-110	0.007	0.208	0.438	0.438	0.006	0.176	0.342	0.342
SR-110 south of I-5	0.007	0.208	0.438	0.438	0.006	0.176	0.342	0.342
SR-110 north of I-5	0.007	0.208	0.438	0.438	0.006	0.176	0.342	0.342
San Fernando Road	0.010	0.253	0.532	0.532	0.010	0.205	0.393	0.393
Riverside Drive	0.010	0.253	0.532	0.532	0.010	0.205	0.393	0.393
Figueroa Street	0.010	0.253	0.532	0.532	0.010	0.205	0.393	0.393
Cypress Ave	0.010	0.253	0.532	0.532	0.010	0.205	0.393	0.393
Pasadena Ave	0.010	0.253	0.532	0.532	0.010	0.205	0.393	0.393
Stadium Way	0.010	0.253	0.532	0.532	0.010	0.205	0.393	0.393
W Ave 26	0.010	0.253	0.532	0.532	0.010	0.205	0.393	0.393
North Broadway	0.010	0.253	0.532	0.532	0.010	0.205	0.393	0.393
Eagle Rock Boulevard	0.010	0.253	0.532	0.532	0.010	0.205	0.393	0.393

Table C-8. Truck DPM Emission Factors - 2014 and 2017

Roadway Segment	DPM Emission Factor (g/mi)							
	2014				2017			
	2 axle	3 axle	4 axle	5 axle	2 axle	3 axle	4 axle	5 axle
I-5 south of SR-110	0.006	0.120	0.147	0.147	0.005	0.076	0.093	0.093
I-5 north of SR-110	0.006	0.120	0.147	0.147	0.005	0.076	0.093	0.093
SR-110 south of I-5	0.006	0.120	0.147	0.147	0.005	0.076	0.093	0.093
SR-110 north of I-5	0.006	0.120	0.147	0.147	0.005	0.076	0.093	0.093
San Fernando Road	0.009	0.130	0.196	0.196	0.008	0.061	0.066	0.066
Riverside Drive	0.009	0.130	0.196	0.196	0.008	0.061	0.066	0.066
Figueroa Street	0.009	0.130	0.196	0.196	0.008	0.061	0.066	0.066
Cypress Ave	0.009	0.130	0.196	0.196	0.008	0.061	0.066	0.066
Pasadena Ave	0.009	0.130	0.196	0.196	0.008	0.061	0.066	0.066
Stadium Way	0.009	0.130	0.196	0.196	0.008	0.061	0.066	0.066
W Ave 26	0.009	0.130	0.196	0.196	0.008	0.061	0.066	0.066
North Broadway	0.009	0.130	0.196	0.196	0.008	0.061	0.066	0.066
Eagle Rock Boulevard	0.009	0.130	0.196	0.196	0.008	0.061	0.066	0.066

Note:

1. Source for emission factors: California Air Resources Board, EMFAC2011.
   Website: http://www.arb.ca.gov/msei/modeling.htm#emfac2011_web_based_data. Run for Los Angeles County vehicle population on 5/15/2012.

Table C-9. Truck DPM Emissions within 1 Mile of CMF - 2010 and 2012

Roadway Segment	DPM Emissions (lb/yr)									
	2010					2012				
	2 axle	3 axle	4 axle	5 axle	Total	2 axle	3 axle	4 axle	5 axle	Total
I-5 south of SR-110	16.8	179.4	122.9	2,599.8	2,918.8	17.4	167.0	105.4	2,227.1	2,516.9
I-5 north of SR-110	38.4	411.7	281.8	5,963.6	6,695.6	40.1	383.3	241.7	5,114.4	5,779.4
SR-110 south of I-5	7.2	27.3	3.2	12.3	50.0	6.6	22.0	2.2	8.6	39.4
SR-110 north of I-5	6.0	3.9	0.0	0.0	9.8	5.3	3.1	0.0	0.0	8.5
San Fernando Road	6.8	18.8	8.8	30.7	65.1	6.5	15.3	6.5	22.8	51.0
Riverside Drive	4.0	11.0	5.1	18.0	38.1	3.8	9.0	3.8	13.4	29.9
Figueroa Street	3.9	10.8	5.0	17.6	37.3	3.7	8.8	3.7	13.1	29.2
Cypress Ave	3.8	10.5	4.9	17.1	36.3	3.6	8.5	3.6	12.7	28.5
Pasadena Ave	6.3	17.4	8.1	28.4	60.2	6.0	14.1	6.0	21.1	47.2
Stadium Way	1.4	3.8	1.8	6.3	13.3	1.3	3.1	1.3	4.7	10.4
W Ave 26	2.3	6.4	3.0	10.5	22.2	2.2	5.2	2.2	7.8	17.4
North Broadway	0.4	1.1	0.5	1.8	3.8	0.4	0.9	0.4	1.3	2.9
Eagle Rock Boulevard	2.7	7.5	3.5	12.2	25.9	2.6	6.1	2.6	9.1	20.3
Total (lb/yr)					**9,976**					**8,581**
Total (ton/yr)					**4.99**					**4.29**

Table C-10. Truck DPM Emissions within 1 Mile of CMF - 2014 and 2017

Roadway Segment	DPM Emissions (lb/yr)									
	2014					2017				
	2 axle	3 axle	4 axle	5 axle	Total	2 axle	3 axle	4 axle	5 axle	Total
I-5 south of SR-110	16.1	114.7	45.6	964.4	1,140.8	14.7	73.0	29.2	617.7	734.6
I-5 north of SR-110	37.0	263.2	104.7	2,214.7	2,619.6	33.8	167.5	67.0	1,418.4	1,686.7
SR-110 south of I-5	6.1	15.1	1.0	3.7	25.9	5.5	9.6	0.6	2.4	18.2
SR-110 north of I-5	4.9	2.1	0.0	0.0	7.1	4.5	1.4	0.0	0.0	5.9
San Fernando Road	6.0	9.8	3.3	11.4	30.4	5.2	4.6	1.1	3.9	14.8
Riverside Drive	3.5	5.7	1.9	6.7	17.8	3.1	2.7	0.6	2.3	8.7
Figueroa Street	3.4	5.6	1.9	6.5	17.4	3.0	2.6	0.6	2.2	8.5
Cypress Ave	3.3	5.4	1.8	6.4	17.0	2.9	2.6	0.6	2.2	8.3
Pasadena Ave	5.5	9.0	3.0	10.6	28.1	4.8	4.3	1.0	3.6	13.7
Stadium Way	1.2	2.0	0.7	2.3	6.2	1.1	0.9	0.2	0.8	3.0
W Ave 26	2.0	3.3	1.1	3.9	10.4	1.8	1.6	0.4	1.3	5.1
North Broadway	0.3	0.6	0.2	0.7	1.8	0.3	0.3	0.1	0.2	0.9
Eagle Rock Boulevard	2.4	3.9	1.3	4.5	12.1	2.1	1.8	0.4	1.5	5.9
Total (lb/yr)					**3,935**					**2,514**
Total (ton/yr)					**1.97**					**1.26**

Table C-11. Freight Train Duty Cycle - Time in Notch

Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8
0%	0%	50%	50%	0%	0%	0%	0%	0%	0%

Notes:

1. Source: Union Pacific Railroad Company, 2007. *Toxic Air Contaminant Emissions Inventory and Dispersion Modeling Report for the Los Angeles Transportation Center, Los Angeles, California* . Final Report. Prepared by Sierra Research and Robert G. Ireson. February 23. Appendix A-3. The duty cycle corresponds to an average train speed of 10 mph.

Table C-12. Line Haul Locomotive Emission Factors for Southern California

Year	DPM Emission Factor (g/hp-hr)
2010	0.23
2012	0.20
2014	0.17
2017	0.14

Notes:

1. Emission factors were calculated from g/gal factors published in *EPA Technical Highlights: Emission Factors for Locomotives,* EPA-420-F-09-025, April 2009.
2. Emission factors assume a line haul locomotive fuel consumption rate of 20.8 bhp-hr per gallon of fuel, from *EPA Technical Highlights: Emission Factors for Locomotives* , EPA-420-F-09-025, April 2009.

Table C-13. Notch-Specific Adjustment Factors for Line Haul Locomotives

Notch	Adjustment Factor for PM
DB	10.16
Idle	16.83
1	1.62
2	1.33
3	1.33
4	0.94
5	0.79
6	0.83
7	0.72
8	0.76

Notes:

1. These adjustment factors are applied to EPA duty cycle emission factors in g/bhp-hr when notch-specific emission factors are needed.
2. These adjustment factors were derived from emissions and load factor data used to develop the EPA duty cycle emission factors in *Locomotive Emission Standards - Regulatory Support Document* (U.S. EPA, April 1998).

Table C-14. Freight Train Activity on Mainline within 1 Mile of the CMF

LATC Train Type	No. of Trains	Working Locos per Consist	Movement Speed (mph)	No. of Locos	Distance Traveled (mi)	Travel Time (loco-hr)	Average loco size (hp)	Engine Load Factor at Notch 1	Loco Work Done at Notch 1 (hp-hr/yr)	Engine Load Factor at Notch 2	Loco Work Done at Notch 2 (hp-hr/yr)
Through N to E	97	3.23	10	313	3.08	96.6	4,400	5.0%	10,622	11.4%	24,218
Through E to N	669	2.14	10	1,432	3.08	441.2	4,400	5.0%	48,536	11.4%	110,662
Through S to N	360	2.96	10	1,066	3.08	328.4	4,400	5.0%	36,126	11.4%	82,367
Through N to S	646	3.14	10	2,028	3.08	625.2	4,400	5.0%	68,768	11.4%	156,791
Arrivals from N	344	2.52	10	867	3.08	267.2	4,400	5.0%	29,389	11.4%	67,007
Arr & Dep N to E	29	2.83	10	82	3.08	25.3	4,400	5.0%	2,782	11.4%	6,344
Arr & Dep E to N	101	2.54	10	257	3.08	79.1	4,400	5.0%	8,697	11.4%	19,830
Arr & Dep S to N	7	1.86	10	13	3.08	4.0	4,400	5.0%	441	11.4%	1,006
Arr & Dep N to S	153	2.14	10	327	3.08	100.9	4,400	5.0%	11,100	11.4%	25,308
Power Through N to E	52	1.50	10	78	3.08	24.0	4,400	5.0%	2,644	11.4%	6,029
Power Through E to N	23	1.50	10	35	3.08	10.6	4,400	5.0%	1,170	11.4%	2,667
Power Through S to N	4	1.50	10	6	3.08	1.8	4,400	5.0%	203	11.4%	464
Power Through N to S	21	1.50	10	32	3.08	9.7	4,400	5.0%	1,068	11.4%	2,435
Power from N	3	1.50	10	5	3.08	1.4	4,400	5.0%	153	11.4%	348
Total	**2,509**		**10**	**6,539**	**3.08**	**2,015**	4,400	5.0%	**221,700**	11.4%	**505,476**

Notes:
1. Source: LATC 2005 Emission Inventory, Table 6.
2. Distance traveled was measured on an aerial map.

Table C-15. Freight Train Emissions Within 1 Mile of CMF

Analysis Year	No. of Trains (trains/yr)	Segment Length (mi)	DPM Emission Rate (ton/yr)
2010	2,509	3.08	0.26
2012	2,509	3.08	0.22
2014	2,509	3.08	0.20
2017	2,509	3.08	0.16

Table C-16. Metrolink Fleet-Average HEP Engine Emission Factors

Analysis Year	DPM Emission Factor (g/hp-hr)
2010	0.211
2012	0.217
2014	0.222
2017	0.144

Note: The fleet-average emission factors were derived from Tables B-65 through B-68 in Appendix B.

Table C-17. Metrolink Systemwide Locomotive Usage Apportionment

Loco Model	Percent of Fleet			
	2010	2012	2014	2017
F59PH	29%	29%	29%	8%
F59PHI	27%	27%	27%	8%
F40PH	1%	1%	1%	0%
MP36PH-3C	29%	29%	29%	23%
59PH Repowered	14%	14%	14%	11%
F125	0%	0%	0%	50%
Total	**100%**	**100%**	**100%**	**100%**

Note: Relative locomotive usage for the Metrolink fleet was provided by Metrolink.

Table C-18. Metrolink Fleet-Average Locomotive Emission Factors

Duty Cycle	Power in Notch (bhp)	Fuel Rate (lb/hr)	BSFC (lb/bhp-hr)	DPM Emission Factor (g/hr)
Year 2010				
ML3	788	291	0.37	160
ML45	1,282	462	0.36	268
ML56	1,678	597	0.36	380
Year 2012				
ML3	788	291	0.37	160
ML45	1,282	462	0.36	268
ML56	1,678	597	0.36	380
Year 2014				
ML3	788	291	0.37	160
ML45	1,282	462	0.36	268
ML56	1,678	597	0.36	380

Notes:

1. ML3 = traveling on mainline at Notch 3; ML45 = traveling on mainline at Notches 4 and 5; ML56 = traveling on mainline at Notches 5 and 6.
2. The fleet-average emission factors were derived from Table C-12 in Appendix C and Tables B-20, B-22, B-24, B-26, B-28, and B-30 in Appendix B.
3. Fleet average emission factors for 2017 are not shown because they involve proprietary Tier 4 emission factors.

Table C-19. Passenger Train Usage Within 1 Mile of CMF

Train Description	Segment Length (mi)	No. of Trains (trains/yr)	Notch Setting	Duty Cycle	Average Speed (mph)	No. Locos per Train	No. HEP Engines per Train, 2010-2014	No. HEP Engines per Train, 2017	Avg. HEP In-Use Power (hp)	Total Loco Travel (loco-mi/yr)	Total HEP Travel, 2010-2014 (HEP-mi/yr)	Total HEP Travel, 2017 (HEP-mi/yr)	Loco Dwell Time (hr/yr)	HEP Usage, 2010-2014 (hp-hr/yr)	HEP Usage, 2017 (hp-hr/yr)
Metrolink CMF Trains NB	0.96	8,499	N4 or N5	ML45	50	1.03	0.99	0.54	165	8,390	8,015	4,379	168	26,525	14,493
Metrolink CMF Trains SB	0.96	8,499	N4 or N5	ML45	50	1.03	0.99	0.54	165	8,390	8,015	4,379	168	26,525	14,493
Metrolink Union Station Trains EB/SB	3.08	8,291	N3	ML3	50	1.03	0.99	0.54	165	26,361	25,182	13,759	527	83,334	45,532
Metrolink Union Station Trains WB/NB	3.08	8,551	N5 or N6	ML56	50	1.03	0.99	0.54	165	27,190	25,974	14,191	544	85,954	46,964
Amtrak Trains SB	3.08	2,190	N3	ML3	50	1.17	1.00	1.00	165	7,875	6,750	6,750	157	22,336	22,336
Amtrak Trains NB	3.08	2,190	N5 or N6	ML56	50	1.17	1.00	1.00	165	7,875	6,750	6,750	157	22,336	22,336

Notes:

1. Metrolink train counts, notch settings, and average speeds were provided by Metrolink. The No. of locomotives and HEP engines per train, and the average HEP in-use power were obtained from usage data for the CMF emission calculations.
2. Metrolink CMF trains travel between the CMF and Union Station. "Metrolink Union Station Trains" represent Metrolink trains that travel on the mainline in and out of Union Station and do not stop at the CMF.
3. Amtrak train counts were obtained from Amtrak schedules for the Coast Starlight and Pacific Surfliner as of 6/27/2014. The Coast Starlight was assume to have 2 locomotives per train, and the Pacific Surfliner was assumed to have 1 locomotive per train. All locomotives were assumed to have a separate HEP engine. Notch settings, average speed, and average HEP in-use power were assumed to be similar to Metrolink trains.

Table C-20. Passenger Train HEP Engine Emissions Within 1 Mile of CMF

Train Description	HEP Usage (hp-hr/yr)	No. of Trains (trains/yr)	DPM Emission Rate (ton/yr)
Year 2010			
Metrolink CMF Trains NB	26,525	8,499	0.006
Metrolink CMF Trains SB	26,525	8,499	0.006
Metrolink Union Station Trains EB/SB	83,334	8,291	0.019
Metrolink Union Station Trains WB/NB	85,954	8,551	0.020
Amtrak Trains SB	22,336	2,190	0.005
Amtrak Trains NB	22,336	2,190	0.005
Year 2012			
Metrolink CMF Trains NB	26,525	8,499	0.006
Metrolink CMF Trains SB	26,525	8,499	0.006
Metrolink Union Station Trains EB/SB	83,334	8,291	0.020
Metrolink Union Station Trains WB/NB	85,954	8,551	0.021
Amtrak Trains SB	22,336	2,190	0.005
Amtrak Trains NB	22,336	2,190	0.005
Year 2014			
Metrolink CMF Trains NB	26,525	8,499	0.007
Metrolink CMF Trains SB	26,525	8,499	0.007
Metrolink Union Station Trains EB/SB	83,334	8,291	0.020
Metrolink Union Station Trains WB/NB	85,954	8,551	0.021
Amtrak Trains SB	22,336	2,190	0.005
Amtrak Trains NB	22,336	2,190	0.005
Year 2017			
Metrolink CMF Trains NB	14,493	8,499	0.002
Metrolink CMF Trains SB	14,493	8,499	0.002
Metrolink Union Station Trains EB/SB	45,532	8,291	0.007
Metrolink Union Station Trains WB/NB	46,964	8,551	0.007
Amtrak Trains SB	22,336	2,190	0.005
Amtrak Trains NB	22,336	2,190	0.005

Note: On-site CMF emissions are excluded.

Table C-21. Passenger Train Locomotive Main Engine Emissions Within 1 Mile of CMF

Train Description	Loco Dwell Time (hr/yr)	Duty Cycle	No. of Trains (trains/yr)	DPM Emission Rate (ton/yr)
Year 2010				
Metrolink CMF Trains NB	168	ML45	8,499	0.05
Metrolink CMF Trains SB	168	ML45	8,499	0.05
Metrolink Union Station Trains EB/SB	527	ML3	8,291	0.09
Metrolink Union Station Trains WB/NB	544	ML56	8,551	0.23
Amtrak Trains SB	157	ML3	2,190	0.03
Amtrak Trains NB	157	ML56	2,190	0.07
Year 2012				
Metrolink CMF Trains NB	168	ML45	8,499	0.05
Metrolink CMF Trains SB	168	ML45	8,499	0.05
Metrolink Union Station Trains EB/SB	527	ML3	8,291	0.09
Metrolink Union Station Trains WB/NB	544	ML56	8,551	0.23
Amtrak Trains SB	157	ML3	2,190	0.03
Amtrak Trains NB	157	ML56	2,190	0.07
Year 2014				
Metrolink CMF Trains NB	168	ML45	8,499	0.05
Metrolink CMF Trains SB	168	ML45	8,499	0.05
Metrolink Union Station Trains EB/SB	527	ML3	8,291	0.09
Metrolink Union Station Trains WB/NB	544	ML56	8,551	0.23
Amtrak Trains SB	157	ML3	2,190	0.03
Amtrak Trains NB	157	ML56	2,190	0.07
Year 2017				
Metrolink CMF Trains NB	168	ML45	8,499	0.03
Metrolink CMF Trains SB	168	ML45	8,499	0.03
Metrolink Union Station Trains EB/SB	527	ML3	8,291	0.04
Metrolink Union Station Trains WB/NB	544	ML56	8,551	0.12
Amtrak Trains SB	157	ML3	2,190	0.03
Amtrak Trains NB	157	ML56	2,190	0.07

Note: On-site CMF emissions are excluded.

Table C-22. Passenger Train Total Main and HEP Engine Emissions Within 1 Mile of CMF

Train Description	No. of Trains (trains/yr)	DPM Emission Rate (ton/yr)
Year 2010		
Metrolink CMF Trains	16,999	0.112
Metrolink Union Station Trains	16,842	0.360
Amtrak Trains	4,380	0.104
Year 2012		
Metrolink CMF Trains	16,999	0.112
Metrolink Union Station Trains	16,842	0.361
Amtrak Trains	4,380	0.104
Year 2014		
Metrolink CMF Trains	16,999	0.112
Metrolink Union Station Trains	16,842	0.362
Amtrak Trains	4,380	0.105
Year 2017		
Metrolink CMF Trains	16,999	0.058
Metrolink Union Station Trains	16,842	0.174
Amtrak Trains	4,380	0.105

Note: On-site CMF emissions are excluded.

Table C-23. Stationary Facilities Identified within 1 Mile of the CMF

Facility ID	Facility Name	Street	City, State, Zip
1	A & I Auto Body & Paint Shop / AB Autobody Shop	3011 Verdugo Rd	Los Angeles, CA 90065
2	Aero Engines Inc.	2926-34 N Coolidge Ave	Los Angeles, CA 90039
3	Alvarado Alta Calidad	2905 Humboldt St	Los Angeles, CA 90031
4	American West Finishing	3200 N Figueroa St	Los Angeles, CA 90065
5	Ameripride Services Inc.	3505 Pasadena Ave	Los Angeles, CA 90031
6	Angelica Textile Services	451 N San Fernando Rd	Los Angeles, CA 90031
7	Bimbo Bakery USA, Bimbo LA	1801 Blake Ave	Los Angeles, CA 90039
8	Bivans Corp.	2431 Dallas St	Los Angeles, CA 90031
9	Burger King, Unite & Jose Checa	3241 N Figueroa St	Los Angeles, CA 90065
10	Caltrans	2133 Riverside Dr	Los Angeles, CA 90039
11	Chevron Dlr, Sheik Ramessar / G & M Oil Co, LLC #88	2601 N Figueroa St	Los Angeles, CA 90065
12	City Of LA, BOS, Wastewater Coll Sys Div	303.5 N San Fernando Rd	Los Angeles, CA 90031
13	Convenience Retailers LLC - 2705605	2250 N Figueroa St	Los Angeles, CA 90065
14	Custom Woodworks, Louis Bedini	2971 Partridge Ave	Los Angeles, CA 90039
15	Day O Graphics	3055 Humboldt St	Los Angeles, CA 90031
16	Desert Petroleum, Inc.	2000 N Figueroa St	Los Angeles, CA 90065
17	Diana's Gas, Diana Chan DBA / Hancor Investments Inc.	2600 N Figueroa St	Los Angeles, CA 90065
18	El Pollo Loco	2201 N Broadway	Los Angeles, CA 90031
19	Fine Art Solutions Inc.	3559 N Figueroa St	Los Angeles, CA 90065
20	Framatic	1921 Blake Ave	Los Angeles, CA 90039
21	Frisco Baking Co Inc.	621 W Avenue 26	Los Angeles, CA 90065
22	Goodwill Ind of So Cal	342 N San Fernando Rd	Los Angeles, CA 90031
23	Grindley Mfg Inc.	1989 Blake Ave	Los Angeles, CA 90039
24	HI Electronics Inc.	2945 Denby Ave	Los Angeles, CA 90039
25	Intl Auto Body & Sales	2411 Sichel St	Los Angeles, CA 90031
26	J T Auto Sales & Body Shop	2920 Eagle Rock Blvd	Los Angeles, CA 90065
27	JSL Foods Inc.	3550 Pasadena Ave	Los Angeles, CA 90031
28	K & K Oil Inc. DBA Broadway 76	2001 N Broadway	Los Angeles, CA 90031
29	K M Office Services Inc.	1731 N Spring St	Los Angeles, CA 90012
30	Kung's Auto Repair & Body Shop	151 S Avenue 24	Los Angeles, CA 90031
31	LA City, Dept of Gen Serv, Fire Sta #401	140 N Avenue 19	Los Angeles, CA 90031
32	LA City, Dept of Gen Serv,Dorris Pl 21-1	2335 Dorris Pl	Los Angeles, CA 90031

Table C-23. Stationary Facilities Identified within 1 Mile of the CMF (continued)

Facility ID	Facility Name	Street	City, State, Zip
33	LA City, Dept of Gen Services	1831 Pasadena Ave	Los Angeles, CA 90031
34	LA City, Dept of Gen Services	1266 Stadium Way	Los Angeles, CA 90026
35	LA City, Dept of Gen Servs - No. Central	452-460 N San Fernando Rd	Los Angeles, CA 90031
36	LA City, DWP	1561 N Broadway	Los Angeles, CA 90012
37	LA Co., Metropolitan Trans Authority	630 W Avenue 28	Los Angeles, CA 90065
38	LA Dodgers Inc. / Dodger Stadium	1000 Elysian Park Ave	Los Angeles, CA 90012
39	LA Uni Sch Dist, Nightingale Middle Sch	3311 N Figueroa St	Los Angeles, CA 90065
40	LA Unified Dist, Loreto Elementary Sch	3408 Arroyo Seco Ave	Los Angeles, CA 90065
41	Los Angeles DWP	2633 Artesian St	Los Angeles, CA 90031
42	Los Angeles Stripping & Finishing Center	1120 N San Fernando Rd	Los Angeles, CA 90065
43	Mission Kleensweep Products Inc.	2434 Birkdale St	Los Angeles, CA 90031
44	Natl Wire & Cable Corp.	136 N San Fernando Rd	Los Angeles, CA 90031
45	Northwestern Showcase & Fixture Co	1683 Blake Ave	Los Angeles, CA 90031
46	P & A Auto Body	2353 San Fernando Rd	Los Angeles, CA 90065
47	Pacific Bell, AT&T California, DBA	2445 Daly St	Los Angeles, CA 90031
48	Patra Drive In #2	2319 San Fernando Rd	Los Angeles, CA 90065
49	Peking Noodle Co Inc.	1514 San Fernando Rd	Los Angeles, CA 90065
50	Prime Collision Center	716-720 N San Fernando Rd	Los Angeles, CA 90065
51	SC Fuel Stop	2135 San Fernando Rd	Los Angeles, CA 90065
52	Self-Realization Fellowship Church	3208 Humboldt St	Los Angeles, CA 90031
53	Self-Realization Fellowship Church	3225 Lacy St	Los Angeles, CA 90031
54	Self-Realization Fellowship Church	3880 San Rafael Ave	Los Angeles, CA 90065
55	Serv-Rite Meat Co Inc.	2515 San Fernando Rd	Los Angeles, CA 90065
56	Stadco	1931 N Broadway	Los Angeles, CA 90031
57	Tesoro (USA) 63070	2214 N Broadway	Los Angeles, CA 90031
58	Tesoro (USA) 63279	2251 N Figueroa St	Los Angeles, CA 90065
59	The Bromack Company	3005 Humboldt St	Los Angeles, CA 90031
60	Vent Vue Window Products	2424 Glover Pl	Los Angeles, CA 90031
61	Wrights Supply, Inc. DBA Gory Electric	2015 San Fernando Rd	Los Angeles, CA 90065

Notes:

1. Sources: South Coast AQMD. Facility INformation Detail (FIND) Database. http://www3.aqmd.gov/webappl/fim/prog/search.aspx. Website accessed May 2014; and California Air Resources Board. Facility Search Engine. http://www.arb.ca.gov/app/emsinv/facinfo/facinfo.php. Website accessed May 2014.

Appendix D

Dispersion Model Input Data

Figure D-1. AERMOD Source Representation – Locomotive Idling at the CMF – All Years

Figure D-2. AERMOD Source Representation – Locomotive Brake Testing at the CMF - 2010

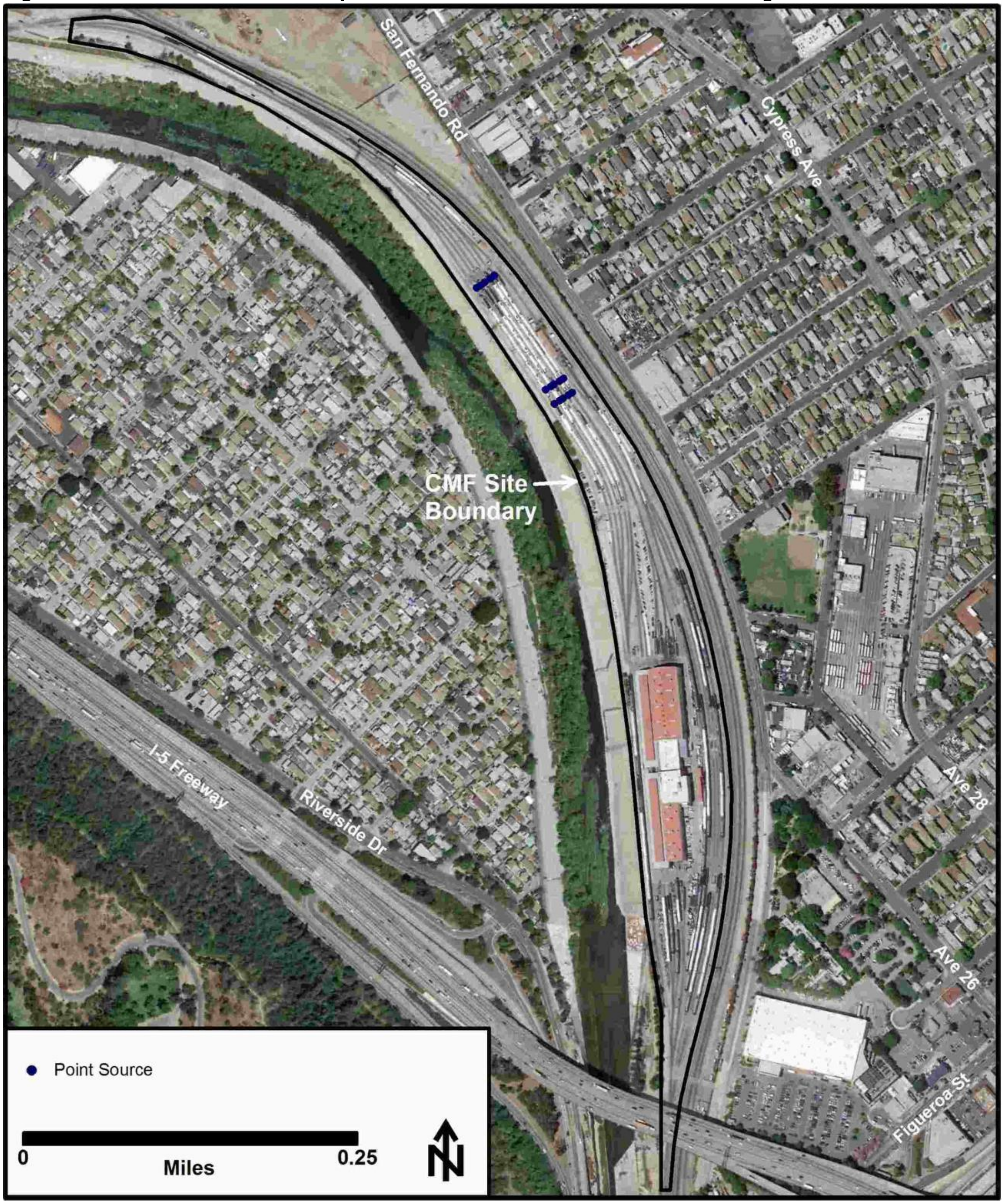


Figure D-3. AERMOD Source Representation – Locomotive Brake Testing at the CMF – 2012, 2014, and 2017

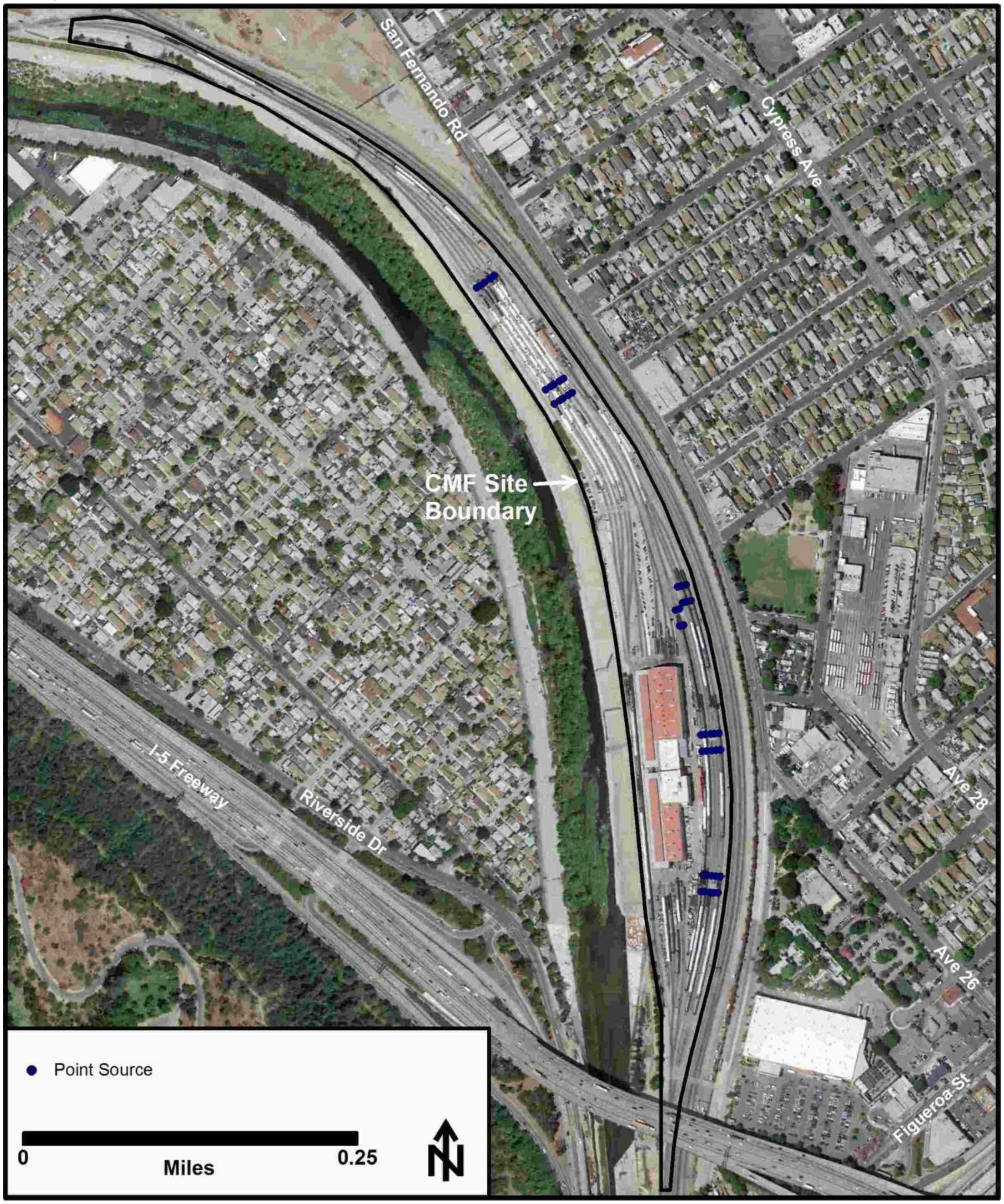


Figure D-4. AERMOD Source Representation – Locomotive Load Testing at the CMF – All Years

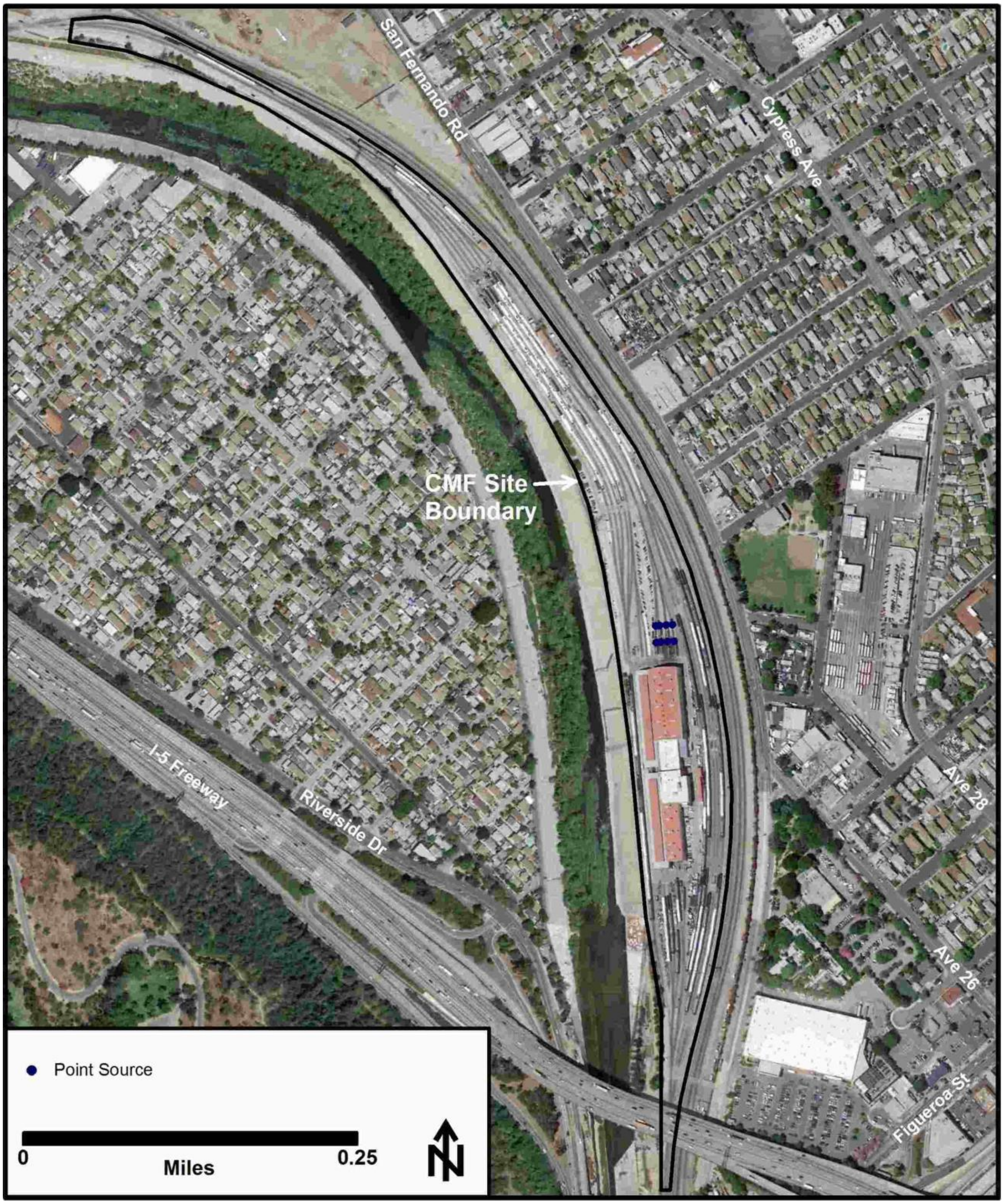


Figure D-5. AERMOD Source Representation – Locomotives on Moving Trains at the CMF – All Years

Figure D-6. AERMOD Source Representation – Locomotives and the Diesel Rail Car Mover Performing Switching at the CMF – All Years

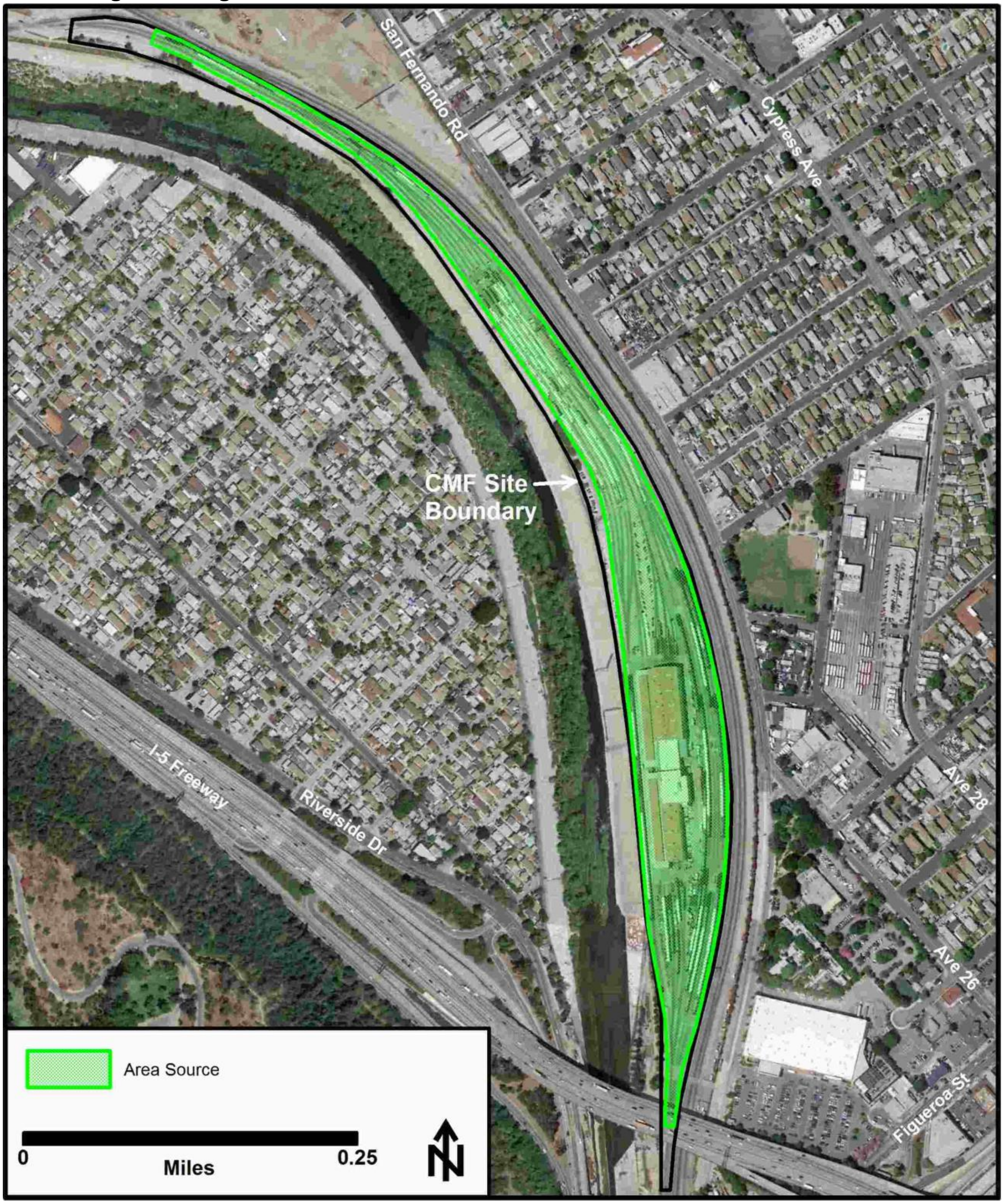


Figure D-7. AERMOD Source Representation – HEP Engines on Stationary Trains at the CMF – All Years

Figure D-8. AERMOD Source Representation – HEP Engine Load Testing at the CMF – All Years

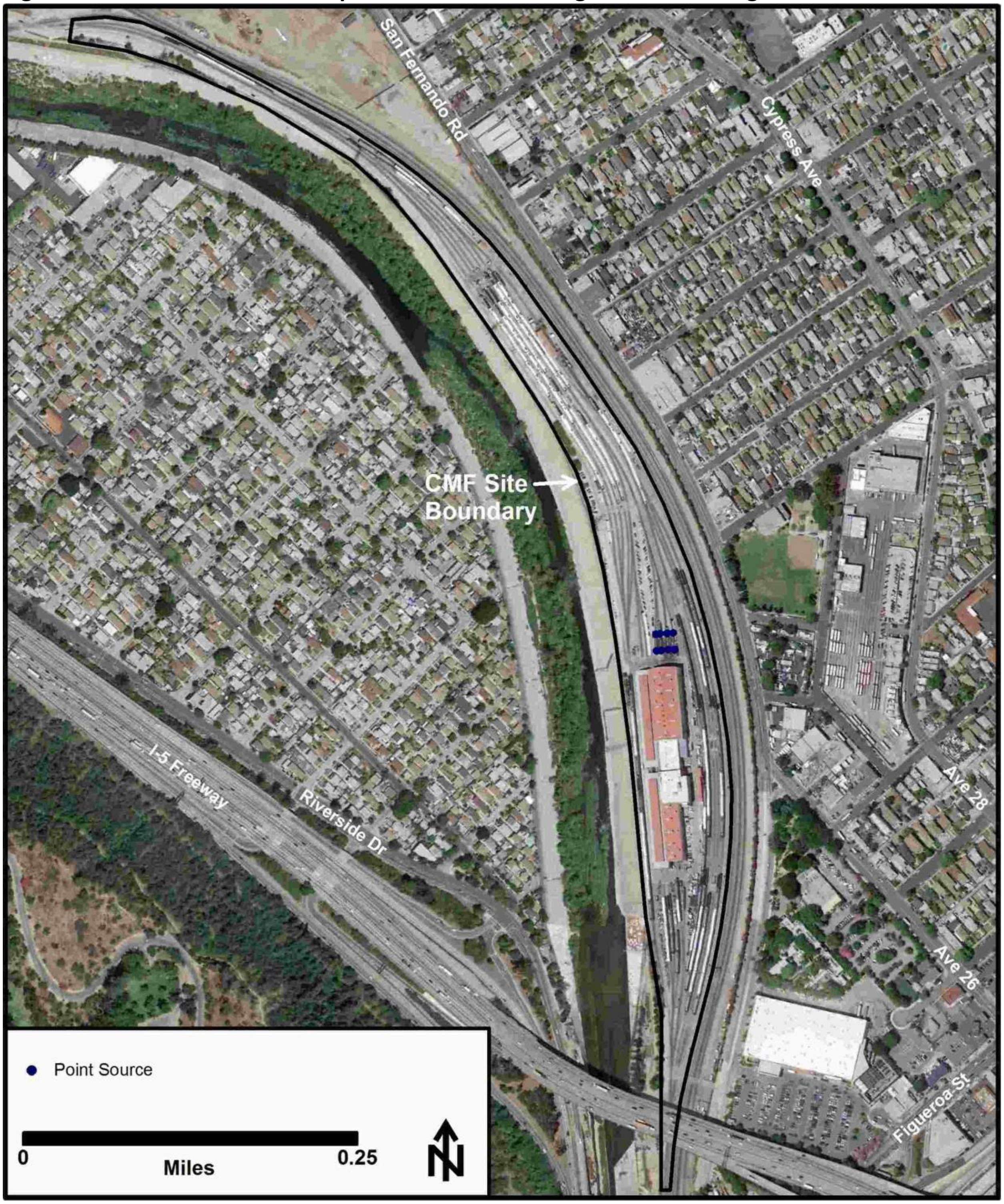


Figure D-9. AERMOD Source Representation – HEP Engines on Moving Trains at the CMF – 2010

Figure D-10. AERMOD Source Representation – HEP Engines on Moving Trains at the CMF – 2012, 2014, and 2017

Figure D-11. AERMOD Source Representation – Standby Diesel Generators at the CMF – All Years

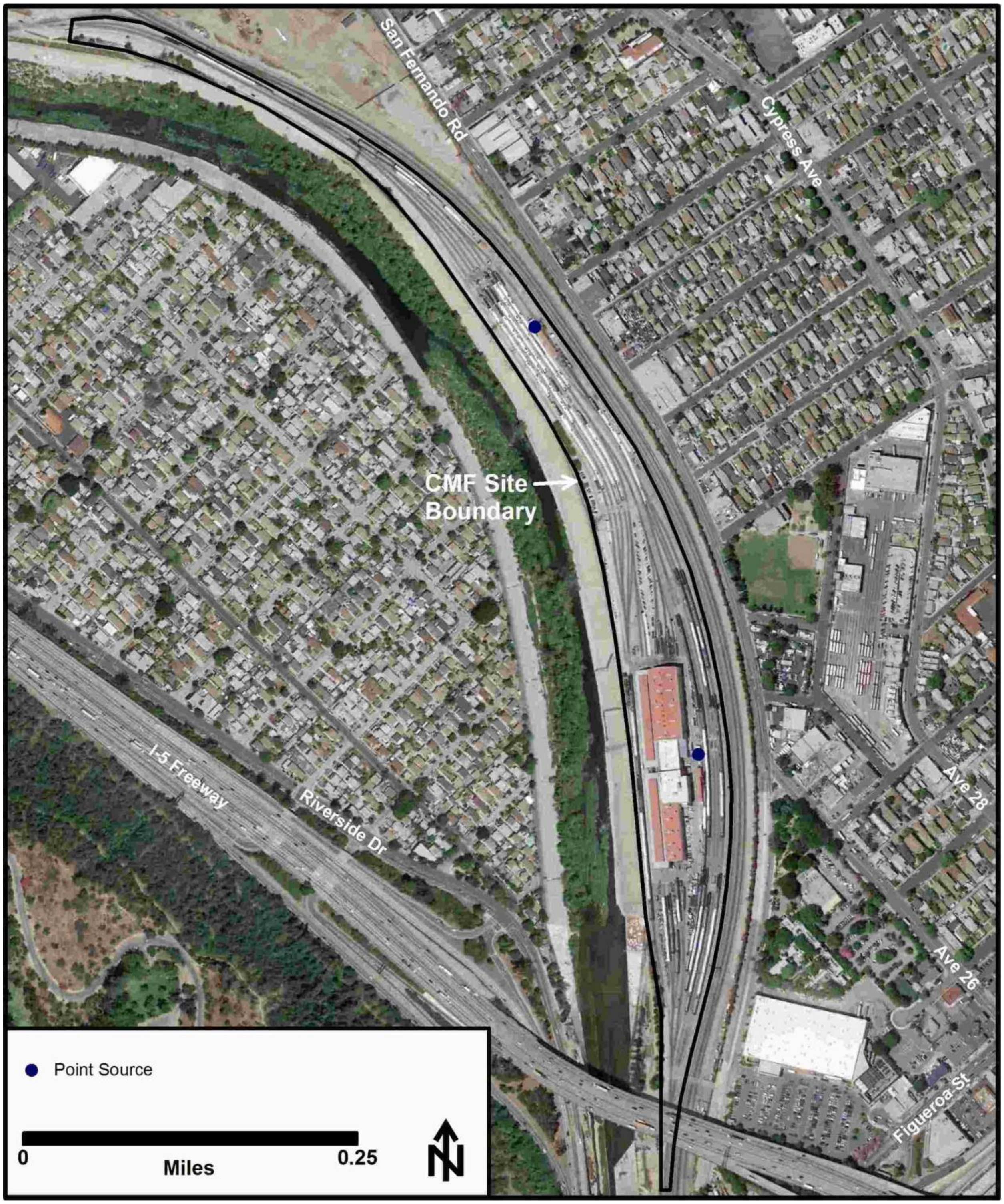


Figure D-12. AERMOD Source Representation – Diesel Forklifts and Welder at the CMF – All Years

Figure D-13. AERMOD Source Representation – Diesel Trucks at the CMF – All Years

Figure D-14. AERMOD Source Representation – Off-Site Diesel Trucks within 1 Mile of the CMF – All Years

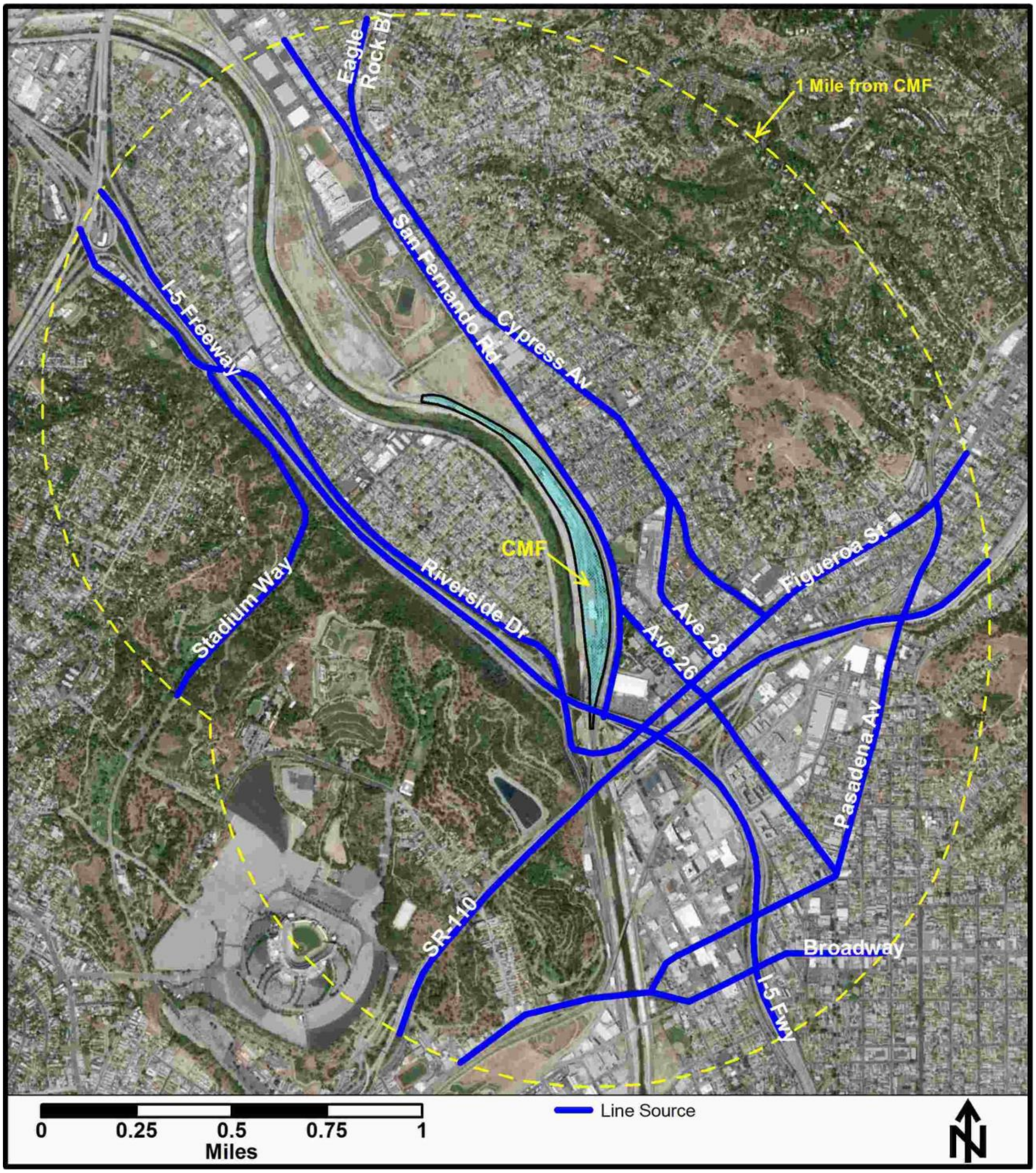


Figure D-15. AERMOD Source Representation – Off-Site Trains within 1 Mile of the CMF – All Years

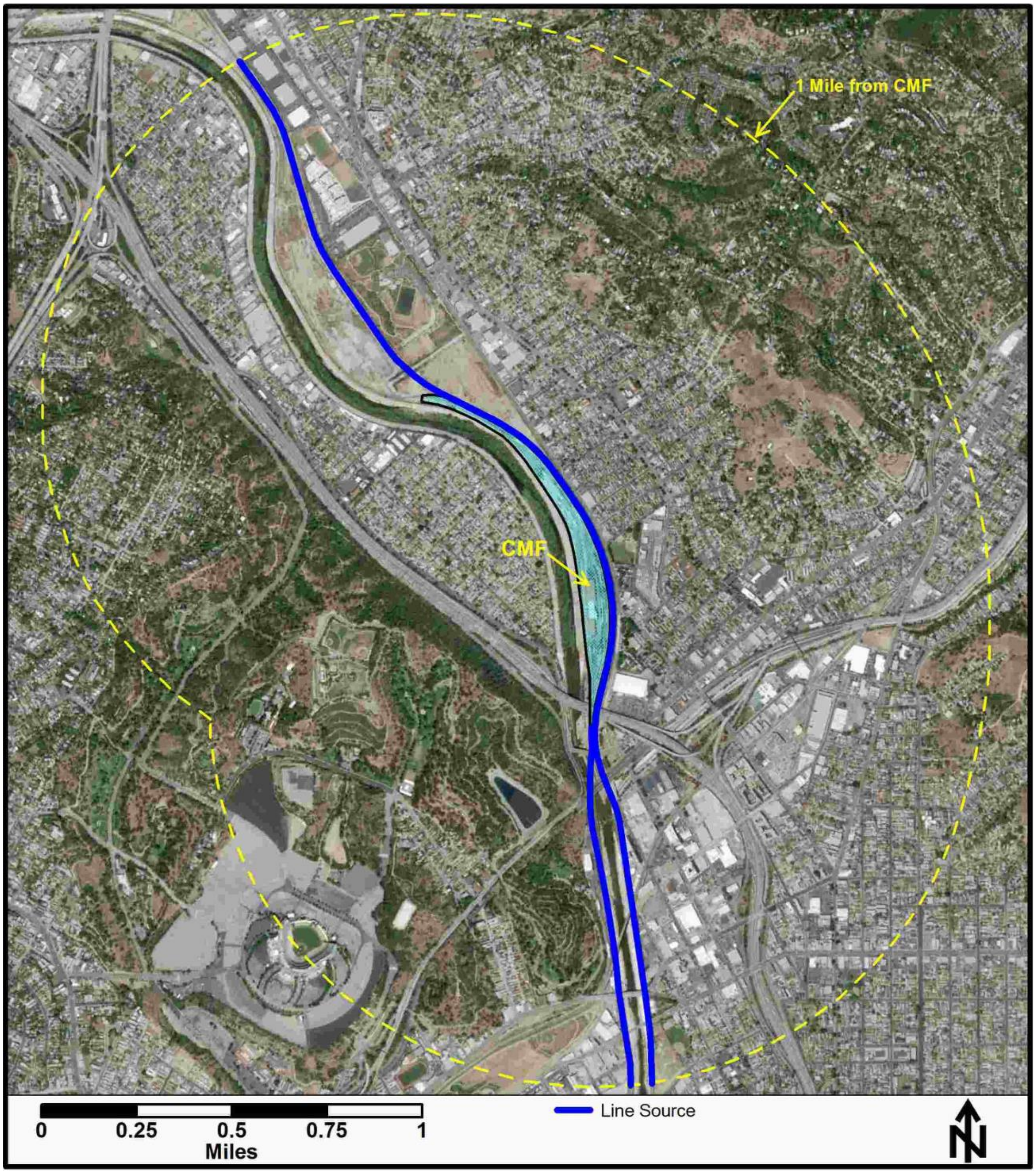
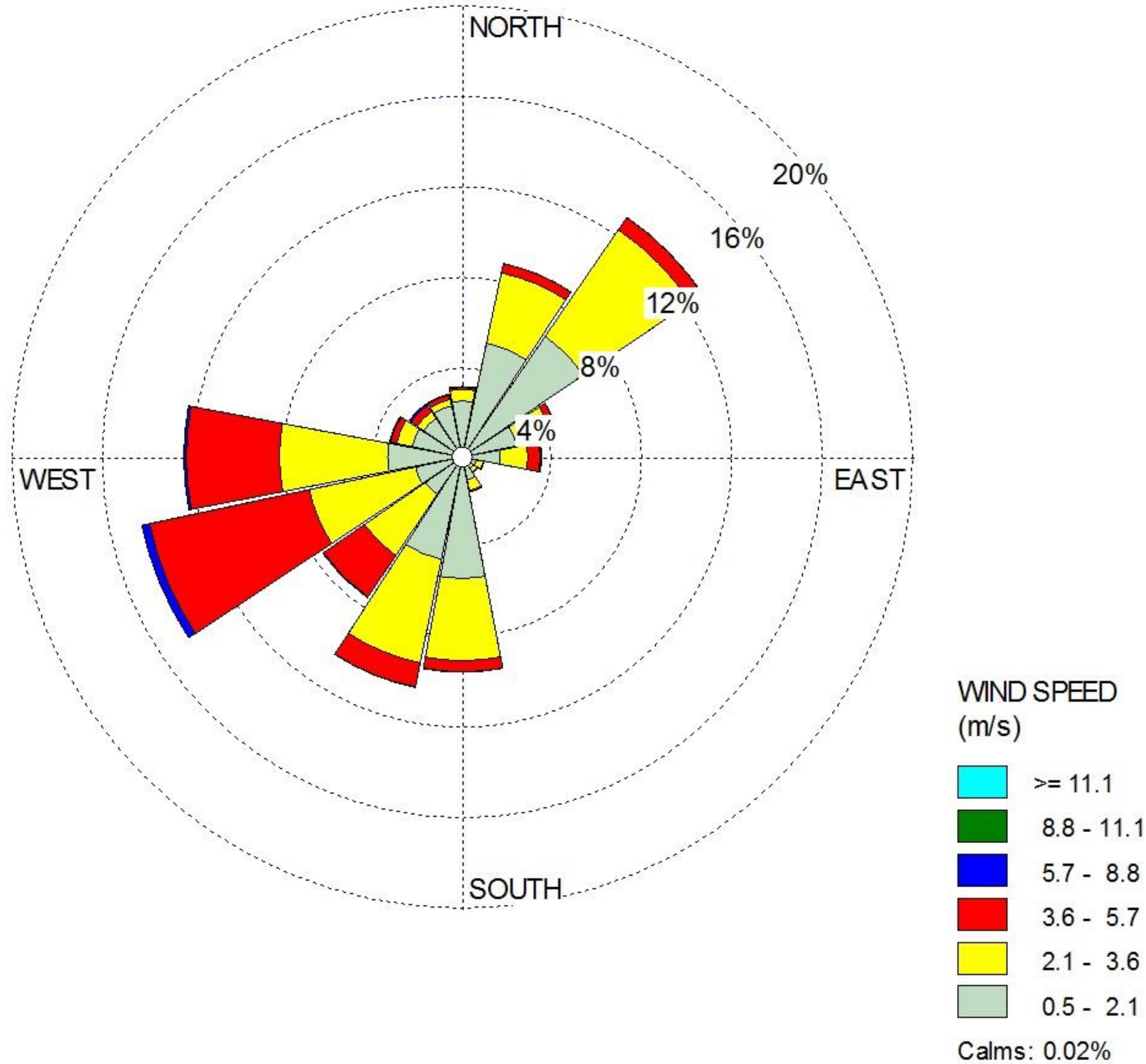


Figure D-16. Meteorological Data Frequency of Wind Speed and Direction – CELA Station



Note: Directions are <u>from</u> which the wind blows.

Table D-1. Source Parameters for Dispersion Modeling

Source	Source Type	Release Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp. (K)	Source Width (m)	Initial Vertical Dimension σ_z (m) [1]
CMF On-Site Sources							
Locomotives Idling [2]	Point	4.6	0.666	3.73	351	n/a	n/a
Locomotives Idling at Notch 8 [2,3]	Point	4.6	0.666	26.89	661	n/a	n/a
Locomotives Brake Test [2,4]	Point	4.6	0.666	11.38	530	n/a	n/a
Locomotives Brake Test at Notch 8 [2,3]	Point	4.6	0.666	26.89	661	n/a	n/a
Locomotives Load Testing [2,4]	Point	4.6	0.666	16.98	573	n/a	n/a
Locomotives on Moving Trains – Day [5,6]	Line	12.2	n/a	n/a	n/a	9.0	5.66
Locomotives on Moving Trains – Night [5,6]	Line	23.2	n/a	n/a	n/a	9.0	10.77
Locomotives Performing Switching – Day [5,7]	Area [8]	10.2	n/a	n/a	n/a	n/a	4.72
Locomotives Performing Switching – Night [5,7]	Area [8]	21.3	n/a	n/a	n/a	n/a	9.89
HEP Engines on Stationary Trains [9]	Point	4.6	0.144	39.54	591	n/a	n/a
HEP Engines Load Test [9]	Point	4.6	0.144	62.91	695	n/a	n/a
HEP Engines on Moving Trains – Day [5,10]	Line	8.3	n/a	n/a	n/a	9.0	3.87
HEP Engines on Moving Trains – Night [5,10]	Line	20.0	n/a	n/a	n/a	9.0	9.32
Standby Generator No. 1 [11,12]	Point	2.2	0.095	75.3	823	n/a	n/a
Standby Generator No. 2 [13,12]	Point	2.1	0.146	89.9	800	n/a	n/a
Forklifts and Welder [14]	Area [8]	4.2	n/a	n/a	n/a	n/a	1.93
Diesel Rail Car Mover – Day [5,15]	Area [8]	3.5	n/a	n/a	n/a	n/a	1.65
Diesel Rail Car Mover – Night [5,15]	Area [8]	6.3	n/a	n/a	n/a	n/a	2.93
Fuel and Delivery Trucks [14,16]	Line	4.2	n/a	n/a	n/a	10.0	1.93
Off-Site Sources							
Freight Trains on Mainline – Day [17,18]	Line	5.6	n/a	n/a	n/a	9.0	2.60
Freight Trains on Mainline - Night [17,18]	Line	14.6	n/a	n/a	n/a	9.0	6.77
Passenger Trains on Mainline – Day [5,19]	Line	4.8	n/a	n/a	n/a	9.0	2.25
Passenger Trains on Mainline - Night [5,19]	Line	18.4	n/a	n/a	n/a	9.0	8.54
On-Road Trucks [14,16]	Line	4.2	n/a	n/a	n/a	variable	1.93

Notes:

1. Consistent with the *Roseville Rail Yard Study*, the initial vertical dimension (σ_z) represents the source release height divided by a standard deviation of 2.15.
2. Stationary locomotives were modeled as point sources. The source parameters by throttle notch setting were obtained from the *Roseville Rail Yard Study* (CARB, October 14, 2004) for the engine type (EMD 16-645E3B) most representative of the Metrolink CMF fleet.
3. Metrolink has one locomotive in its current fleet (F40PH) that has no separate HEP engine. The main engine must run at Notch 8 when providing HEP power.
4. The values for exit velocity and exit temperature for the brake test and load test were averaged using time-in-notch duty cycles provided by Metrolink.

Notes for Table D-1, continued:

5. Release height equals a locomotive stack height of 4.6 meters (for the locomotive main engine or HEP engine) or 3.5 meters (for the diesel railcar mover) plus the plume rise calculated by the U.S. EPA SCREEN3 screening-level dispersion model. SCREEN3 was run with urban dispersion parameters, a stack diameter of 0.666 meters for locomotive main engines, 0.144 meters for HEP engines, or 0.12 meters for the diesel railcar mover, and the following locomotive/railcar dimensions to simulate downwash effects: height of 4.57 meters, minimum horizontal dimension of 3.0 meters, and maximum horizontal dimension of 20 meters. Daytime conditions were represented in SCREEN3 with Stability D and an average ambient air temperature of 294 K. Nighttime conditions were represented with Stability F and an average ambient air temperature of 288 K.
6. Plume rise for locomotives on moving trains at the CMF was calculated with the following additional SCREEN3 stack parameters: exit velocity of 6.18 m/s, exit temperature of 413 K, an average daytime wind speed of 2.8 m/s, and an average nighttime travel/wind speed of 2.24 m/s.
7. Plume rise for locomotives performing switching at the CMF was calculated with the following additional SCREEN3 stack parameters: exit velocity of 5.42 m/s, exit temperature of 399 K, an average daytime wind speed of 2.8 m/s, and an average nighttime travel/wind speed of 2.24 m/s.
8. Area sources will cover the approximate area in which source emissions regularly occur.
9. Stack parameters for the HEP engines were provided by Metrolink and Caterpillar (Gen Set Package Performance Data. Models 3406CDITA and C27. Provided by Jessica Lamboo. March 25, 2014). Stack parameters were interpolated from the average engine power while on trains and during load tests.
10. Plume rise for HEPs on moving trains at the CMF was calculated with the following additional SCREEN3 stack parameters: exit velocity of 39.54 m/s, exit temperature of 591 K, an average daytime wind speed of 2.8 m/s, and an average nighttime travel/wind speed of 2.24 m/s.
11. Release height and stack diameter were provided by Metrolink. Temperature and flow rate (used to derive exit velocity) were provided by Cummins Engine Company (6BTA5.9-G2 Advantage Data Sheet, June 19, 2000).
12. Because the standby generators have rain caps, they were modeled in AERMOD using the raincap beta option. The stack parameters in this table are prior to any adjustments made by AERMOD to account for the effects of the raincap.
13. Release height and stack diameter were provided by Metrolink. Temperature and flow rate (used to derive exit velocity) were provided by Cummins Power Generation (S-1146i Data Sheet, June 2006).
14. Consistent with the CARB Rail Yard HRAs (CARB 2007), on-road trucks and diesel yard equipment were modeled using the release height and vertical dispersion parameter (σ_z) from the CARB *Diesel Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles.* (October, 2000), Appendix VII, Table 2.
15. Plume rise for the diesel railcar mover performing switching at the CMF was calculated with the following additional SCREEN3 stack parameters: exit velocity of 9.84 m/s, exit temperature of 811 K, an average daytime wind speed of 2.8 m/s, and an average nighttime travel/wind speed of 2.24 m/s.
16. For on-road vehicles, the line source width represents the width of the travelled way plus a 3-meter mixing zone width on either side. The width will vary off-site depending on the roadway being modeled.
17. Source parameters for freight train movement were obtained from the *Roseville Rail Yard Study*, Table G-1 (notch 2). Separate source parameters are provided for daytime (6am-6pm) and nighttime (6pm-6am) meteorological conditions.
18. The line source width of 9.0 meters represents the locomotive width (approximately 3 meters) plus a 3-meter mixing zone width on either side.
19. Plume rise for off-site passenger trains was calculated with the following additional SCREEN3 stack parameters: exit velocity of 13.3 m/s, exit temperature of 556 K, a daytime wind speed of 20 m/s (the maximum allowed by SCREEN3 with Stability D) and a nighttime wind speed of 4.0 m/s (the maximum allowed by SCREEN3 with Stability F). The plume rise at an average travel/wind speed of 50 mph (22.35 m/s) was adjusted by assuming the plume rise is proportional to (1/WS)^(1/3).

Table D-2. Diurnal Emission Profiles for CMF Sources

Description	12am-4am	4am-8am	8am-12pm	12pm-4pm	4pm-8pm	8pm-12am	Total
Locos Moving All Years, HEP Moving 2010 - Rivertrack to S&I N - DAY	0%	14%	55%	20%	12%	0%	**100%**
Locos Moving All Years, HEP Moving 2010 - S&I N to Storage A - DAY	0%	0%	45%	48%	7%	0%	**100%**
Locos Moving All Years, HEP Moving 2010 - Storage A to Exit - DAY	0%	0%	8%	76%	16%	0%	**100%**
Locos Moving All Years, HEP Moving 2010 - Rivertrack to S&I N - NIGHT	0%	0%	0%	0%	0%	100%	**100%**
Locos Moving All Years, HEP Moving 2010 - S&I N to Storage A - NIGHT	0%	0%	0%	0%	0%	100%	**100%**
Locos Moving All Years, HEP Moving 2010 - Storage A to Exit - NIGHT	0%	0%	0%	0%	100%	0%	**100%**
HEP Moving 2012-2017 - Rivertrack to S&I N - DAY	0%	3%	11%	3%	82%	0%	**100%**
HEP Moving 2012-2017 - Storage C to Exit - DAY	0%	0%	6%	75%	19%	0%	**100%**
HEP Moving 2012-2017 - Rivertrack to S&I N - NIGHT	0%	0%	0%	0%	0%	100%	**100%**
HEP Moving 2012-2017 - Storage C to Exit - NIGHT	0%	0%	0%	0%	100%	0%	**100%**
Locos Idling 2010 - Rivertrack	0%	4%	55%	40%	0%	2%	**100%**
Locos Idling 2010 - S&I	0%	3%	44%	48%	5%	1%	**100%**
Locos Idling 2010 - Storage	0%	0%	27%	69%	4%	0%	**100%**
Locos Idling 2012-2017 - Rivertrack	0%	8%	68%	21%	0%	3%	**100%**
Locos Idling 2012-2017 - S&I	0%	5%	55%	31%	7%	3%	**100%**
Locos Idling 2012-2017 - Storage	0%	2%	43%	50%	5%	0%	**100%**
Locos Brake Test 2010 - S&I	0%	2%	61%	34%	3%	0%	**100%**
Locos Brake Test 2012-2017 - S&I	0%	0%	55%	39%	5%	0%	**100%**
Locos Brake Test 2012-2017 - Storage	0%	3%	68%	29%	0%	0%	**100%**
HEP Idling 2010 - Rivertrack	0%	4%	55%	40%	0%	2%	**100%**
HEP Idling 2010 - S&I	0%	3%	45%	46%	5%	2%	**100%**
HEP Idling 2010 - Storage	0%	0%	27%	69%	4%	0%	**100%**
HEP Idling 2012-2017 - Rivertrack	0%	8%	68%	21%	0%	3%	**100%**
HEP Idling 2012-2017 - S&I	0%	0%	48%	42%	11%	0%	**100%**
HEP Idling 2012-2017 - Storage	0%	2%	46%	47%	5%	0%	**100%**
Yard Switching - Rail Car Mover - DAY	0%	0%	0%	0%	100%	0%	**100%**
Yard Switching - Rail Car Mover - NIGHT	0%	0%	0%	0%	50%	50%	**100%**
Yard Switching - Locos - DAY	0%	0%	0%	0%	100%	0%	**100%**
Yard Switching - Locos - NIGHT	0%	0%	0%	0%	50%	50%	**100%**
Loco & HEP Load Testing	0%	0%	45%	45%	10%	0%	**100%**
Trucks Onsite, Forklifts, Welder, Generators	0%	0%	50%	50%	0%	0%	**100%**

Note: CMF emission profiles were developed using activity schedules provided by Metrolink.

Table D-3. Diurnal Emission Profiles for Off-Site Sources

Description	12am-4am	4am-8am	8am-12pm	12pm-4pm	4pm-8pm	8pm-12am	Total
Off-Site Passenger Trains [1]	7%	17%	27%	27%	17%	7%	**100%**
Off-Site Freight Trains	17%	17%	17%	17%	17%	17%	**100%**
Off-Site Trucks on Freeways	17%	17%	17%	17%	17%	17%	**100%**
Off-Site Trucks on Surface Streets [2]	4%	16%	27%	26%	20%	7%	**100%**

Notes:

1. Off-site passenger train emissions are estimated to occur 80 percent during the day (6am-6pm) and 20 percent at night (6pm-6am), based on Metrolink and Amtrak schedules.
2. The profile for trucks on surface streets was derived from the 2013 SCAG Regional Screenline Traffic Count, website: http://web.scag.ca.gov/modeling/screenline.htm. Provided by Iteris (personal communication with Sean Daly, 6/26/2014).

Appendix E

Tables of Estimated Health Risks at Modeled Sensitive Receptors

Table E-1. Estimated Cancer Risk and Chronic Hazard Index at Sensitive Receptors - CMF HRA

Receptor No.	UTM X (m)	UTM Y (m)	Description	Category	Street Address	City	Zip	Estimated Cancer Risk by Emissions Assessment Year (chances per million people) 2010	2012	2014	2017	Estimated Chronic Hazard Index by Emissions Assessment Year 2010	2012	2014	2017
1	387971	3771591	Avenue 28 Head Start/State Preschool	Child Care	220 E Ave 28	Los Angeles	90031	0.4	0.3	0.1	0.1	0.00	0.00	0.00	0.00
2	385029	3772839	Cottage Enrichment	Child Care	2208 Avon Street	Los Angeles	90026	0.3	0.1	0.1	0.1	0.00	0.00	0.00	0.00
3	386854	3773343	Cypress I Preschool	Child Care	1145 Cypress Ave	Los Angeles	90065	8.3	4.2	3.1	1.6	0.02	0.01	0.01	0.00
4	386900	3772736	Cypress Park Head Start	Child Care	2630 Pepper Ave	Los Angeles	90065	34.8	23.0	17.9	8.6	0.09	0.06	0.05	0.02
5	384675	3772550	Echo Park Head Start	Child Care	1962 Echo Park Ave	Los Angeles	90026	0.2	0.1	0.1	0.1	0.00	0.00	0.00	0.00
6	385242	3774142	Escobar Family Child Daycare Provider	Child Care	2008 Blake Ave	Los Angeles	90039	0.2	0.1	0.1	0.0	0.00	0.00	0.00	0.00
7	387551	3771491	Flores De Valle	Child Care	225 N Avenue 25	Los Angeles	90031	0.5	0.3	0.2	0.1	0.00	0.00	0.00	0.00
8	385908	3774483	Glassell Park Early Education Center	Child Care	3003 N Carlyle Street	Los Angeles	90065	0.2	0.1	0.1	0.1	0.00	0.00	0.00	0.00
9	387770	3770768	Jardin De Ninos Child Care Center	Child Care	2422 Manitou Ave	Los Angeles	90031	0.2	0.2	0.1	0.1	0.00	0.00	0.00	0.00
10	385760	3774692	Kedron Head Start & Preschool	Child Care	2415 W Avenue 30	Los Angeles	90065	0.2	0.1	0.1	0.0	0.00	0.00	0.00	0.00
11	386421	3772573	Learning Bear Child Care and Preschool	Child Care	2318 Fernleaf St	Los Angeles	90031	5.1	2.9	2.2	1.1	0.01	0.01	0.01	0.00
12	387849	3771546	Placita De Ninos Inc	Child Care	2261 Pasadena Ave	Los Angeles	90031	0.4	0.3	0.2	0.1	0.00	0.00	0.00	0.00
13	387755	3771019	Arroyo Vista Family Health Center	Medical	2411 N Broadway	Los Angeles	90031	0.5	0.4	0.2	0.1	0.00	0.00	0.00	0.00
14	387416	3772259	Health Care Services Lincoln Heights	Medical	2820 N Figueroa St	Los Angeles	90065	5.4	4.3	2.2	1.2	0.01	0.01	0.00	0.00
15	384819	3773847	Los Angeles Sleep Institute	Medical	1989 Riverside Drive	Los Angeles	90039	0.3	0.1	0.1	0.1	0.00	0.00	0.00	0.00
16	385721	3774600	Santa Maria Family Medical Clinic	Medical	2209 N San Fernando Rd	Los Angeles	90065	0.3	0.2	0.1	0.1	0.00	0.00	0.00	0.00
17	387401	3770557	Albion Elementary School	School	322 S Ave 18	Los Angeles	90031	0.2	0.2	0.1	0.1	0.00	0.00	0.00	0.00
18	387388	3770833	Alliance Susan & Eric Smidt Technology High School; Alliance College-Ready Middle Academy	School	211 S Ave 20	Los Angeles	90031	0.3	0.2	0.1	0.1	0.00	0.00	0.00	0.00
19	386936	3773355	Aragon Avenue Elementary School	School	1118 Aragon Ave	Los Angeles	90065	7.1	3.6	2.7	1.4	0.02	0.01	0.01	0.00
20	384658	3772809	Baxter Montessori School	School	2101 Echo Park Ave	Los Angeles	90026	0.2	0.1	0.1	0.0	0.00	0.00	0.00	0.00
21	386073	3770613	Cathedral High School	School	1253 Bishops Rd	Los Angeles	90012	0.3	0.3	0.2	0.1	0.00	0.00	0.00	0.00
22	387826	3771472	College Ready Middle Academy No. 7	School	2635 Pasadena Ave	Los Angeles	90031	0.4	0.3	0.1	0.1	0.00	0.00	0.00	0.00
23	387156	3772629	Divine Saviour School	School	624 Cypress Ave	Los Angeles	90065	14.5	8.9	6.5	3.1	0.04	0.02	0.02	0.01
24	385851	3772985	Dorris Place Elementary School	School	2225 Dorris Pl	Los Angeles	90031	1.2	0.6	0.5	0.2	0.00	0.00	0.00	0.00
25	384782	3772694	Elysian Heights Elementary School	School	1562 Baxter Street	Los Angeles	90026	0.2	0.1	0.1	0.1	0.00	0.00	0.00	0.00
26	385944	3774423	Glassell Park Elementary School	School	2211 W Avenue 30	Los Angeles	90065	0.3	0.1	0.1	0.1	0.00	0.00	0.00	0.00
27	388106	3772264	Hillside Elementary School	School	120 East Avenue 35	Los Angeles	90031	1.0	0.8	0.4	0.2	0.00	0.00	0.00	0.00
28	387720	3772415	Loreto Street Elementary School	School	3408 Arroyo Seco Ave	Los Angeles	90065	2.3	1.8	1.0	0.5	0.01	0.00	0.00	0.00
29	388215	3771562	Los Angeles Leadership Academy	School	2670 Griffin Ave	Los Angeles	90031	0.3	0.2	0.1	0.1	0.00	0.00	0.00	0.00
30	388308	3772053	Los Angeles Leadership Academy; Crittenton High School	School	234 E Avenue 33	Los Angeles	90031	0.5	0.4	0.2	0.1	0.00	0.00	0.00	0.00
31	385809	3771841	Los Angeles Theatre Academy	School	929 Academy Rd	Los Angeles	90012	0.6	0.4	0.3	0.1	0.00	0.00	0.00	0.00
32	387463	3772513	Nightingale Middle School	School	3311 N Figueroa St	Los Angeles	90065	4.6	3.3	1.9	1.0	0.01	0.01	0.00	0.00
33	386319	3771265	Solano Avenue Elementary School	School	615 Solano Ave	Los Angeles	90012	0.5	0.4	0.2	0.1	0.00	0.00	0.00	0.00
34	385714	3774106	Sonia Sotomayor Learning Academies; Los Angeles River School; Alliance Tennenbaum Family Technology High School	School	2050 N San Fernando Rd	Los Angeles	90065	0.2	0.1	0.1	0.1	0.00	0.00	0.00	0.00
35	386058	3772865	St Ann Religious Education	School	2302 Riverdale Ave	Los Angeles	90031	2.0	1.0	0.8	0.4	0.01	0.00	0.00	0.00
36-68	Multiple	Multiple	LA River User	Recreational	--	--	--	39.2	19.3	15.0	7.5	0.09	0.05	0.04	0.02
69-96	Multiple	Multiple	LA River Bike Path	Recreational	--	--	--	20.2	9.6	7.2	3.6	0.05	0.02	0.02	0.01

Notes:

1. Child Care receptors were evaluated with an exposure of 24 hours per day, 350 days per year, for 9 years, and an elevated (child) breathing rate of 581 L/kg/day.
2. Medical receptors were evaluated with an exposure of 24 hours per day, 350 days per year, for 30 years, and an 80th percentile breathing rate of 302 L/kg/day.
3. School receptors were evaluated with an exposure of 24 hours per day, 350 days per year, for 9 years, and an elevated (child) breathing rate of 581 L/kg/day.
4. Recreational receptors were evaluated with an exposure of 2 hours per day, 245 days per year, for 40 years, and an elevated (exercise) breathing rate of 1,097 L/kg/day.
5. The result for "LA River User" represents the maximally exposed location along the river centerline.
6. The result for "LA River Bike Path" represents the maximally exposed location along the bike path.

Table E-2. Estimated Cancer Risk and Chronic Hazard Index at Sensitive Receptors - Offsite Sources HRA

Receptor No.	UTM X (m)	UTM Y (m)	Description	Category	Street Address	City	Zip	Estimated Cancer Risk by Emissions Assessment Year (chances per million people) 2010	2012	2014	2017	Estimated Chronic Hazard Index by Emissions Assessment Year 2010	2012	2014	2017
1	387971	3771591	Avenue 28 Head Start/State Preschool	Child Care	220 E Ave 28	Los Angeles	90031	12.5	10.7	5.3	3.4	0.03	0.03	0.01	0.01
2	385029	3772839	Cottage Enrichment	Child Care	2208 Avon Street	Los Angeles	90026	6.5	5.7	2.7	1.7	0.02	0.01	0.01	0.00
3	386854	3773343	Cypress I Preschool	Child Care	1145 Cypress Ave	Los Angeles	90065	10.4	9.0	5.1	3.3	0.03	0.02	0.01	0.01
4	386900	3772736	Cypress Park Head Start	Child Care	2630 Pepper Ave	Los Angeles	90065	18.7	16.6	10.5	6.7	0.05	0.04	0.03	0.02
5	384675	3772550	Echo Park Head Start	Child Care	1962 Echo Park Ave	Los Angeles	90026	5.1	4.4	2.1	1.4	0.01	0.01	0.01	0.00
6	385242	3774142	Escobar Family Child Daycare Provider	Child Care	2008 Blake Ave	Los Angeles	90039	15.3	13.3	6.6	4.3	0.04	0.03	0.02	0.01
7	387551	3771491	Flores De Valle	Child Care	225 N Avenue 25	Los Angeles	90031	53.6	46.3	21.7	13.9	0.14	0.12	0.05	0.04
8	385908	3774483	Glassell Park Early Education Center	Child Care	3003 N Carlyle Street	Los Angeles	90065	7.5	6.5	3.7	2.4	0.02	0.02	0.01	0.01
9	387770	3770768	Jardin De Ninos Child Care Center	Child Care	2422 Manitou Ave	Los Angeles	90031	21.8	18.8	9.0	5.8	0.06	0.05	0.02	0.01
10	385760	3774692	Kedron Head Start & Preschool	Child Care	2415 W Avenue 30	Los Angeles	90065	8.0	6.8	4.0	2.5	0.02	0.02	0.01	0.01
11	386421	3772573	Learning Bear Child Care and Preschool	Child Care	2318 Fernleaf St	Los Angeles	90031	29.2	25.3	12.2	7.9	0.07	0.06	0.03	0.02
12	387849	3771546	Placita De Ninos Inc	Child Care	2261 Pasadena Ave	Los Angeles	90031	15.9	13.7	6.7	4.3	0.04	0.03	0.02	0.01
13	387755	3771019	Arroyo Vista Family Health Center	Medical	2411 N Broadway	Los Angeles	90031	38.0	32.8	15.8	10.1	0.06	0.05	0.02	0.01
14	387416	3772259	Health Care Services Lincoln Heights	Medical	2820 N Figueroa St	Los Angeles	90065	31.2	27.0	13.7	8.8	0.05	0.04	0.02	0.01
15	384819	3773847	Los Angeles Sleep Institute	Medical	1989 Riverside Drive	Los Angeles	90039	69.6	60.1	27.8	17.9	0.10	0.09	0.04	0.03
16	385721	3774600	Santa Maria Family Medical Clinic	Medical	2209 N San Fernando Rd	Los Angeles	90065	14.7	12.7	7.7	4.8	0.02	0.02	0.01	0.01
17	387401	3770557	Albion Elementary School	School	322 S Ave 18	Los Angeles	90031	25.1	21.8	10.5	6.8	0.06	0.06	0.03	0.02
18	387388	3770833	Alliance Susan & Eric Smidt Technology High School; Alliance College-Ready Middle Academy	School	211 S Ave 20	Los Angeles	90031	42.8	37.0	17.6	11.3	0.11	0.09	0.04	0.03
19	386936	3773355	Aragon Avenue Elementary School	School	1118 Aragon Ave	Los Angeles	90065	9.2	8.0	4.5	2.9	0.02	0.02	0.01	0.01
20	384658	3772809	Baxter Montessori School	School	2101 Echo Park Ave	Los Angeles	90026	4.7	4.1	2.0	1.3	0.01	0.01	0.00	0.00
21	386073	3770613	Cathedral High School	School	1253 Bishops Rd	Los Angeles	90012	7.7	6.7	3.6	2.3	0.02	0.02	0.01	0.01
22	387826	3771472	College Ready Middle Academy No. 7	School	2635 Pasadena Ave	Los Angeles	90031	17.2	14.8	7.3	4.6	0.04	0.04	0.02	0.01
23	387156	3772629	Divine Saviour School	School	624 Cypress Ave	Los Angeles	90065	13.4	11.7	6.4	4.1	0.03	0.03	0.02	0.01
24	385851	3772985	Dorris Place Elementary School	School	2225 Dorris Pl	Los Angeles	90031	67.0	57.8	26.8	17.3	0.17	0.15	0.07	0.04
25	384782	3772694	Elysian Heights Elementary School	School	1562 Baxter Street	Los Angeles	90026	5.2	4.5	2.2	1.4	0.01	0.01	0.01	0.00
26	385944	3774423	Glassell Park Elementary School	School	2211 W Avenue 30	Los Angeles	90065	7.5	6.5	3.7	2.4	0.02	0.02	0.01	0.01
27	388106	3772264	Hillside Elementary School	School	120 East Avenue 35	Los Angeles	90031	8.5	7.3	3.7	2.4	0.02	0.02	0.01	0.01
28	387720	3772415	Loreto Street Elementary School	School	3408 Arroyo Seco Ave	Los Angeles	90065	11.6	10.0	5.0	3.2	0.03	0.03	0.01	0.01
29	388215	3771562	Los Angeles Leadership Academy	School	2670 Griffin Ave	Los Angeles	90031	8.0	6.9	3.4	2.2	0.02	0.02	0.01	0.01
30	388308	3772053	Los Angeles Leadership Academy; Crittenton High School	School	234 E Avenue 33	Los Angeles	90031	6.0	5.2	2.6	1.7	0.02	0.01	0.01	0.00
31	385809	3771841	Los Angeles Theatre Academy	School	929 Academy Rd	Los Angeles	90012	6.1	5.2	2.5	1.6	0.02	0.01	0.01	0.00
32	387463	3772513	Nightingale Middle School	School	3311 N Figueroa St	Los Angeles	90065	12.8	11.1	5.7	3.6	0.03	0.03	0.01	0.01
33	386319	3771265	Solano Avenue Elementary School	School	615 Solano Ave	Los Angeles	90012	9.2	7.9	4.3	2.8	0.02	0.02	0.01	0.01
34	385714	3774106	Sonia Sotomayor Learning Academies; Los Angeles River School; Alliance Tennenbaum Family Technology High School	School	2050 N San Fernando Rd	Los Angeles	90065	12.9	11.5	7.2	4.7	0.03	0.03	0.02	0.01
35	386058	3772865	St Ann Religious Education	School	2302 Riverdale Ave	Los Angeles	90031	28.7	24.8	11.9	7.7	0.07	0.06	0.03	0.02
36-68	Multiple	Multiple	LA River User	Recreational	--	--	--	49.2	42.8	21.4	13.8	0.12	0.10	0.05	0.03
69-96	Multiple	Multiple	LA River Bike Path	Recreational	--	--	--	66.4	57.4	27.5	17.7	0.16	0.14	0.06	0.04

Notes:

1. Child Care receptors were evaluated with an exposure of 24 hours per day, 350 days per year, for 9 years, and an elevated (child) breathing rate of 581 L/kg/day.
2. Medical receptors were evaluated with an exposure of 24 hours per day, 350 days per year, for 30 years, and an 80th percentile breathing rate of 302 L/kg/day.
3. School receptors were evaluated with an exposure of 24 hours per day, 350 days per year, for 9 years, and an elevated (child) breathing rate of 581 L/kg/day.
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5. The result for "LA River User" represents the maximally exposed location along the river centerline.
6. The result for "LA River Bike Path" represents the maximally exposed location along the bike path.